APOLLO S&N Specification
ND 1002240
Original Issue Date:
Release Authority: TDRR 13817
Class A Release

PROCESS SPECIFICATION

FOR

POTTING OF CONNECTORS USING

SILICONE RUBBER POTTING COMPOUND

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA
1/19/65	A	1555P3	i, 1, 3, 4	WH.	WJR

This specification consists of page i to 4 inclusive.

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APPROVALS			
	W J Rhine 10-20-64 NASA/MSC	A M Peverini W Taylor 18 Jan 65 MIT/IL	S Mullins W. Anderson 12/16/64 L DeSonia 12/10/64 RIC

PROCESS SPECIFICATION

FOR

POTTING OF CONNECTORS USING

SILICONE RUBBER POTTING COMPOUND

1 SCOPE

1-1 Scope - This document covers two methods for the Potting of Connectors with Silicone Rubber Potting Compound.

1-1.1 Method A - Covers the procedure and curing of Silicone Rubber Compound, 24 hours minimum at room temperature.

1-1.2 Method B - Covers the procedure and curing of Silicone Rubber Compound 6 hours minimum at 115° ± 5°F.

2 APPLICABLE DOCUMENTS

2-1 The following documents form a part of this specification to the extent specified herein.

Specifications	
Federal	
BB-F-671	FREON, T.F.
Drawings	
NASA Drawings	Nomenclature
1012515	Compound, Potting-Silicone Rubber
1012514	Catalyst
1012513	Primer, Silicone

4.1.2 All surfaces to be potted shall be completely primed by application of 1012513 primer. Application may be accomplished by use of soft bristle brush or other suitable method. This primer coating shall be allowed to air dry for 15 minutes at room ambient temperature.

4.1.3 Place connectors in appropriate potting molds, dress wires and harness in potting area.

4.2 MIXING OF POTTING MATERIALS

4.2.1 Thoroughly mix the following materials at room temperature in a smooth sided container.

FORMULA

Silicone Rubber Compound per 1012515	25 ± 1 gram
Catalyst per SCD 1012514	1.0 ± 0.1 gram

Note #1. Pot life of this mixture is 1 to 3 hours at room temperature.

Note #2. Ratio of 25:1 to be maintained, amount mixed can be varied.

4.2.2 Evacuate the resin mixture to 20 mm Hg (0.8 inches Hg) maximum alternately pulling vacuum and breaking to atmospheric pressure until number of air bubbles reaching surface are minimized.

4.2.3 Fill the syringe to one-half its volume with the resin mixture.

4.2.4 Inject the resin mixture into the specified areas on the connector. Use caution to minimize the entrapment of air by keeping end of syringe at lowest level.

4.3 CLEANING - Clean off any excess silicone rubber mixture with a spatula or equivalent.

4.4 CURING - Cure the potted connector using one of the following cure cycles.

Method A - 24 hours minimum at room temperature

Method B - 6 hours minimum at $115^{o} \pm 5^{o}$ F

CAUTION - Excessive temperatures can cause incomplete curing because of volatilization of catalyst.

4.5 Remove assembly from mold, and trim off any excess resin.

5 QUALITY ASSURANCE PROVISIONS

5.1 The cured silicone rubber shall have filled or covered the required space and be in intimate contact with the surfaces for which it was intended.

5.2 The encapsulated area shall present a clean, smooth, tough, rubbery, non-tacky surface. To the naked eye it shall be free of voids, flashiness, and surface defects.

5.3 QUALIFICATION OF MATERIALS - Prior to encapsulation, the materials to be used in each production lot shall be tested as follows:

5.3.1 At least 50 grams shall be mixed per paragraph 4.2.1 and evacuated per paragraph 4.2.2. The sample mixture shall then be poured into a mold having a volume of 1 cubic inch and cured per paragraph 4.4.

5.3.2 The 1 cubic inch volume sample (dimensions-1/4" x 2" x2") shall be weighed and the density caluclated. The parent batch of materials from which the sample cube is made shall not be used if the density is not equal to 18.5 ± 1.5 grams/in^3.

5.4 SHELF LIFE. - The silicone rubber compound shall have a shelf life 12 months from date marked on container.

6 NOTES. None.

APOLLO G&N Specification
ND 1002240
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POTTING OF CONNECTORS USING

SILICONE RUBBER POTTING COMPOUND

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA
1-19-65	A	15583	i, 1, 3, 4	WK	W.J.R.
9-2-66	B	30980	1, 2, 3	J.P.	N/A

This specification consists of page i to 4 inclusive.

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APPROVALS	W J Kehrer 10-20-66 NASA/MSC	A M Lewen W Gruber for 10-14-66 MIT/IL	Walter Vin Anderson 10/14/66 L DeBonis 10/10/66 KIC

PROCESS SPECIFICATION

FOR

POTTING OF CONNECTORS USING

SILICONE RUBBER POTTING COMPOUND

1 SCOPE

1-1 Scope - This document covers two methods for the Potting of Connectors with Silicone Rubber Potting Compound.

1-1.1 Method A - Covers the procedure and curing of Silicone Rubber Compound, 24 hours minimum at room temperature.

1-1.2 Method B - Covers the procedure and curing of Silicone Rubber Compound 6 hours minimum at $115^{\circ} \pm 5^{\circ}$F.

2 APPLICABLE DOCUMENTS

2-1 The following documents form a part of this specification to the extent specified herein.

Specifications	
Federal	
BB-F-671	FREON, T. F.
ND 1002146	Process Specification for Etching of Teflon

Drawings	
NASA Drawings	Nomenclature
1012515	Compound, Potting-Silicone Rubber
1012514	Catalyst
1010900	Primer,
1012513	Primer, Silicone

3. MATERIALS AND EQUIPMENT

3.1 Silicone Rubber Compound per 1012515

3.2 Curing agent per 1012514

3.3 Primer per SCD 1010900 or 1012513

3.4 FREON TF per federal specification BB-B-671

3.5 Circulating air oven capable of maintaining temperatures to $115^{\circ} \pm 5^{\circ}F$

3.6 Balance with gram weights

3.7 Polyethylene syringe, spring activated

3.8 Suitable holding fixture

3.9 Cotton swabs

3.10 Disposable polyethylene containers with smooth inner surface

3.11 Spatula

3.12 Tweezers

3.13 Vacuum system capable of producing a vacuum of 20 mm Hg minimum

3.14 Etching solution; Teflon per 1010702

4. POTTING OF CONNECTORS

4.1 Preparation of Surfaces

4.1.1 All exposed surfaces in general area to be potted shall be cleaned of grease, oil, wax, foreign material, etc, using FREON T.F., or equivalent.

4.1.2 All exposed teflon surfaces in the general area to be potted shall have been or shall be etched using etching solution 1010702 in accordance with ND 1002146

4.1.3 All surfaces to be potted shall be completely primed by application of 1012513 or 1010900 primer. Application may be accomplished by use of soft bristle brush or other suitable method. This primer coating shall be allowed to air dry for 15 minutes at room ambient temperature.

4.1.4 Place connectors in appropriate potting molds, dress wires and harness in potting area.

4.2 MIXING OF POTTING MATERIALS

4.2.1 Thoroughly mix the following materials at room temperature in a smooth sided container.

FORMULA

Silicone Rubber Compound per 1012515	25 ± 1 gram
Catalyst per SCD 1012514	1.0 ± 0.1 gram

Note #1. Pot life of this mixture is 1 to 3 hours at room temperature.

Note #2. Ratio of 25:1 to be maintained, amount mixed can be varied.

4.2.2 Evacuate the resin mixture to 20 mm Hg (0.8 inches Hg) maximum alternately pulling vacuum and breaking to atmospheric pressure until number of air bubbles reaching surface are minimized.

4.2.3 Fill the syringe to one-half its volume with the resin mixture.

4.2.4 Inject the resin mixture into the specified areas on the connector. Use caution to minimize the entrapment of air by keeping end of syringe at lowest level.

4.3 CLEANING - Clean off any excess silicone rubber mixture with a spatula or equivalent.

APOLLO G&N Specification
ND 1002240
Original Issue Date:
Release Authority: TDRR 13817
Class A Release

PROCESS SPECIFICATION

FOR

POTTING OF CONNECTORS USING

SILICONE RUBBER POTTING COMPOUND

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA
1-19-65	A	15583	i, 1, 3, 4	WK	W.J.R.
9-2-66	B	30980	1, 2, 3	J.P.	N/A
9-15-67	C	33077	1, ✓	W.S	R.M

This specification consists of page i to 4 inclusive.

i

APPROVALS			
	W J Rabie 10-20-64 NASA/MSC	A M Peverini W Taylor 16 Jan 65 MIT/IL	S Hall Vd Cinderman 10/16/64 L DeLorio 11/10/64 KIC

i

PROCESS SPECIFICATION

FOR

POTTING OF CONNECTORS USING

SILICONE RUBBER POTTING COMPOUND

1. SCOPE

1-1 Scope - This document covers two methods for the Potting of Connectors with Silicone Rubber Potting Compound.

1-1.1 Method A - Covers the procedure and curing of Silicone Rubber Compound, 24 hours minimum at room temperature.

1-1.2 Method B - Covers the procedure and curing of Silicone Rubber Compound 6 hours minimum at 115° ± 5°F.

2 APPLICABLE DOCUMENTS

2-1 The following documents form a part of this specification to the extent specified herein.

Specifications

Federal	
BB-F-671	FREON, T. F.
ND 1002146	Process Specification for Etching of Teflon

Drawings

NASA Drawings	Nomenclature
1005008	Compound, Potting-Silicone Rubber
1005011	Catalyst
1010900	Primer
1012513	Primer, Silicone

3. MATERIALS AND EQUIPMENT

3.1 Silicone Rubber Compound per 1005008

3.2 Curing agent per 1005011

3.3 Primer per SCD 1010900 or 1012513

3.4 FREON TF per federal specification BB-B-671

3.5 Circulating air oven capable of maintaining temperatures to 115° ± 5°F

3.6 Balance with gram weights

3.7 Polyethylene syringe, spring activated

3.8 Suitable holding fixture

3.9 Cotton swabs

3.10 Disposable polyethylene containers with smooth inner surface

3.11 Spatula

3.12 Tweezers

3.13 Vacuum system capable of producing a vacuum of 20 mm Hg minimum

3.14 Etching solution; Teflon per 1010702

4. POTTING OF CONNECTORS

4.1 Preparation of Surfaces

4.1.1 All exposed surfaces in general area to be potted shall be cleaned of grease, oil, wax, foreign material, etc, using FREON T.F., or equivalent.

4.1.2 All exposed teflon surfaces in the general area to be potted shall have been or shall be etched using etching solution 1010702 in accordance with ND 1002146.

4.1.3 All surfaces to be potted shall be completely primed by application of 1012513 or 1010900 primer. Application may be accomplished by use of soft bristle brush or other suitable method. This primer coating shall be allowed to air dry for 15 minutes at room ambient temperature.

4.1.4 Place connectors in appropriate potting molds, dress wires and harness in potting area.

4.2 MIXING OF POTTING MATERIALS

4.2.1 Thoroughly mix the following materials at room temperature in a smooth sided container.

FORMULA

Silicone Rubber Compound per 1005008	100 parts by weight ± 1%
Catalyst per SCD 1005011	10 parts by weight ± 5%

Note #1. Pot life of this mixture is 1 to 3 hours at room temperature.

4.2.2 Evacuate the resin mixture to 20 mm Hg (0.8 inches Hg) maximum alternately pulling vacuum and breaking to atmospheric pressure until number of air bubbles reaching surface are minimized.

4.2.3 Fill the syringe to one-half its volume with the resin mixture.

4.2.4 Inject the resin mixture into the specified areas on the connector. Use caution to minimize the entrapment of air by keeping end of syringe at lowest level.

4.3 CLEANING - Clean off any excess silicone rubber mixture with a spatula or equivalent.

4.4 CURING - Cure the potted connector using one of the following cure cycles.

Method A - 24 hours minimum at room temperature

Method B - 6 hours minimum at 115° ± 5°F

CAUTION - Excessive temperatures can cause incomplete curing because of volatilization of catalyst.

4.5 Remove assembly from mold, and trim off any excess resin.

5. QUALITY ASSURANCE PROVISIONS

5.1 The cured silicone rubber shall have filled or covered the required space and be in intimate contact with the surface for which it was intended.

5.2 The encapsulated area shall present a clean, smooth, tough, rubbery, non-tacky surface. To the naked eye it shall be free of voids, flashiness, and surface defects.

5.3 QUALIFICATION OF MATERIALS - Prior to encapsulation, the materials to be used in each production lot shall be tested as follows:

5.3.1 At least 50 grams shall be mixed per paragraph 4.2.1 and evacuated per paragraph 4.2.2. The sample mixture shall then be poured into a mold having a volume of 1 cubic inch and cured per paragraph 4.4.

5.3.2 The 1 cubic inch volume sample (dimensions - 1/4" x 2" x 2") shall be weighed and the density calculated. The parent batch of materials from which the sample cube is made shall not be used if the density is not equal to 18.5 ± 1.5 grams/in^3.

5.4 SHELF LIFE. - The silicone rubber compound shall have a shelf life 12 months from date marked on container.

6. NOTES. None.

APOLLO G&N Specification
ND 1002240
Original Issue Date:
Release Authority: TDRR 13817
Class Release

PROCESS SPECIFICATION

FOR

POTTING OF CONNECTORS USING

SILICONE RUBBER POTTING COMPOUND

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA

This specification consists of page 1 to 4 inclusive.

APPROVALS			
	W J Rathmell 10-20-64 NASA/MSC	A M Laveson MIT/IL	Rathmell / W. Anderson 10/16/64 L DeSonis 10/16/64 KIC

APOLLO G&N Specification
NS 1002240
Date

PROCESS SPECIFICATION

FOR

POTTING OF CONNECTORS USING

SILICONE RUBBER POTTING COMPOUND

1. SCOPE

1-1 Scope - This document covers two methods for the Potting of Connectors with Silicone Rubber Potting Compound.

1-1.1 Method A - Covers the procedure and curing of Silicone Rubber Compound, 24 hours at room temperature.

1-1.2 - Method B - Covers the procedure and curing of Silicone Rubber Compound, 4 hours at $115^{\circ} \pm 5^{\circ}$F.

2 APPLICABLE DOCUMENTS

2-1 The following documents form a part of this specification to the extent specified herein.

Specifications	
Federal	
BB-F-671	FREON, T.F.
Drawings	
NASA Drawings	Nomenclature
1012515	Compound, Potting-Silicone Rubber
1012514	Cytalyst
1012513	Primer, Silicone

INCHES

3. MATERIALS AND EQUIPMENT

3-1 Silicone Rubber Compound per 1012515

3.2 Curing agent per 1012514

3.3 Primer per 1012513

3.4 FREON TF per federal specification BB-F-671

3.5 Circulating air oven capable of maintaining temperatures to $115^{\circ} \pm 5^{\circ}F$

3.6 Balance with gram weights

3.7 Polyethylene syringe, spring activated

3.8 Suitable holding fixture

3.9 Cotton swabs

3.10 Disposable polyethylene containers with smooth inner surface

3.11 Spatula

3.12 Tweezers

3.13 Vacuum system capable of producing a vacuum of 20 mm Hg minimum.

4. POTTING OF CONNECTORS

4.1 Preparation of Surfaces

4.1.1 All exposed surfaces in general area to be potted shall be cleaned of grease, oil, wax, foreign material, etc, using FREON T.F., or equivalent.

INCHES

4.1.2 All surfaces to be potted shall be completely primed by application of 1012513 primer. Application may be accomplished by use of soft bristle brush or other suitable method. This primer coating shall be allowed to air dry for 15 minutes at room ambient temperature.

4.1.3 Place connectors in appropriate potting molds, dress wires and centralize harness in potting area.

4.2 MIXING OF POTTING MATERIALS

4.2.1 Thoroughly mix the following materials at room temperature in a smooth sided container.

FORMULA

Silicone Rubber Compound per 1012515	25 ± 1 gram
Catalyst per ND 101214	1.0 ± 0.1 gram

Note #1. Pot life of this mixture is 1 to 3 hours at room temperature.

Note #2. Ratio of 25:1 to be maintained, amount mixed can be varied.

4.2.2 Evacuate the resin mixture to 20 mm Hg (0.8 inches Hg) maximum alternately pulling vacuum and breaking to atmospheric pressure until number of air bubbles reaching surface are minimized.

4.2.3 Fill the syringe to one-half its volume with the resin mixture.

4.2.4 Inject the resin mixture into the specified areas on the connector. Use caution to minimize the entrapment of air by keeping end of syringe at lowest level.

4.3 CLEANING - Clean off any excess silicone rubber mixture with a spatula or equivalent.



APOLLO G&N Specification
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Class A **Release**

APOLLO REQUIREMENTS FOR PROCESS CONTROL AND FABRICATION OF PARALLEL GAP RESISTANCE - WELDED ELECTRONIC CIRCUIT MODULES AND ASSEMBLIES

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA

This specification consists of pages 1 to 17 inclusive.

APPROVALS	NASA/MSC	10/1/65	10/4/65 MIT/IL	5 Oct 65	10/5/65 10/2/65 RASA 10 days

NOT REQUIRED PER LETTER
NASA PP7-65-612

LOC. OF MSTR. RAY

APOLLO REQUIREMENTS FOR PROCESS CONTROL AND FABRICATION OF PARALLEL GAP RESISTANCE - WELDED ELECTRONIC CIRCUIT MODULES AND ASSEMBLIES

1. PURPOSE

1.1 This document establishes the minimum requirements for process control and fabrication of electronic assemblies utilising parallel gap resistance-welding. It also specifies certification and qualification requirements for welding personnel, welding equipment, materials, weld schedules, and defines quality requirements.

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on the date of application of this document form a part of this specification to the extent specified herein.

(a)	ND 1002280	Apollo Parallel Gap Visual Criteria
(b)	ND PS 1015402	Materials Specification (Kovar, Gold Plate)
(c)	ND PS 1015400	Materials Specification (Nickel Ribbon Wire)
(d)	ND 1002281	Apollo Parallel Gap Wiring Standards
(e)	ND 1002268	Apollo Parallel Gap Welding Standard Repairs

2.2 Precedence. The provisions of this specification shall be applicable to all phases of parallel gap welding to the extent specified herein. In the event of conflict between the requirements of the applicable drawings, this specification and other documents cited herein, the requirements of the applicable drawings, this specification and other documents specified herein shall govern in that order.

3. GENERAL REQUIREMENTS

3.1 Fabrication

3.1.1 Welded electronic circuit modules and assemblies shall be fabricated in accordance with the applicable drawings.

3.2 Materials

3.2.1 Materials shall be used that conform to the requirements of Paragraphs 2.1 b and c.

3.3 Equipment

3.3.1 The welding machine shall consist of a controllable electrical energy source or sources, one or more welding heads and electrodes. The equipment must be capable of maintaining accurately and reliably the force, and gap and the controlled pulses of electrical energy to the weldments.

3.3.1.1 The pulse duration, amplitude, and voltage wave form delivered to the electrodes shall be repeatable within ±5% for any given setting.

3.3.1.1.1 Waveform or pulse shape reading cited herein shall closely approximate the growth and decay of the current and/or voltage observed at the electrodes. The waveform or pulse shape requirement may be satisfied by comparing the welder output to a standard waveform or pulse shape on a graticule in conjunction with an oscilloscope with a long persistence screen.

3.3.1.2 The force at the electrodes shall be repeatable within ± 0.25 pounds (114 grams) for each electrode.

3.3.1.3 Welding electrodes shall conform to the contractors' configuration drawings.

3.3.1.3.1 Electrode Gap adjustments for a specified setting must be set within ± .001 inch.

3.3.2 Pull Test Machines shall be capable of pulling at a uniform rate not to exceed 40 inches per minute linear velocity. The machines shall be accurate within 2 per cent of the full-scale-force-readings, or 0.2 pounds, whichever is less.

3.3.3 Binocular Microscopes of 10 diameters power shall be used for inspection of parallel gap welds. Binocular microscopes of 10 diameters minimum shall be used for production welding.

3.3.4 A camera microscope with a minimum capability of 75 diameters shall be used for metallurgical examination.

3.3.5 Electrode force gage.

3.3.5.1 Electrode force gages used shall be readable to 0.125 pound maximum (57 grams) per division.

3.3.6 Equipment shall be available that is capable of measuring the electrical output at the electrodes with the accuracy detailed in Paragraph 4.2.1. Electrical measurements shall be made at the welding surface of the electrodes.

3.4 Handling and Workmanship: Precautions shall be taken to avoid unnecessary handling of components and component leads. To prevent contamination, finger cots or other protective covering shall be worn by welding and inspection personnel.

3.4.1 Surfaces to be welded shall be clean and free of all traces of wax, oil, grease, and other organic contaminants.

3.4.2 Bending of component leads (unless specified) must be avoided. Precautions shall be taken to avoid excessive handling of wires and leads in a manner which may result in bending or kinking.

3.4.3 No identification or handling methods shall be utilized which may contaminate the leads in the zone to be welded.

3.4.4 Components, component leads and jumper wires shall be insulated as specified on the drawing.

3.4.5 Precoating of components, unless otherwise specified on the drawing or process sheet, shall not be done prior to assembly and welding.

3.4.6 Welding surfaces of electrodes showing signs of pitting, pick-up deterioration, contamination, excessive oxidation, wear or other damage shall not be used.

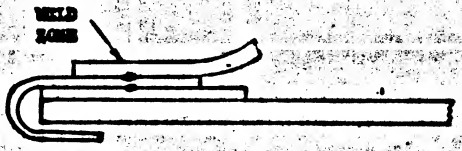
3.4.7 Electrodes may be cleaned with the following:

(a) 600 grit or finer
(b) Methylene chloride
(c) Trichlorethylene
(d) Metal files shall not be used to recondition electrodes on a welding machine at the welding station.

3.4.8 There shall be no dirt or contamination in the electrode gap.

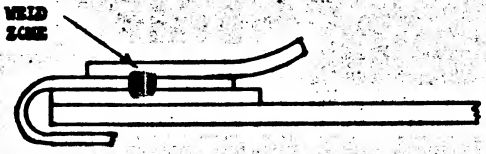
3.4.9 No weld shall be made over an existing weld, (fig. 1) but a single weld may be made on a lamination of materials (fig. 2) to weld the two uppermost weldments.

Figure 1



UNACCEPTABLE

Figure 2



ACCEPTABLE

3.5 Certification and Qualification: Certification and qualification requirements specified in this document shall include requirements for conformance with inspection and test criteria for all welding of assemblies, sub-assemblies, and modules and pass the tests specified herein. Re-certification and requalification requirements, when applicable, shall conform to the same certification and qualification requirements.

4. PROCESS CONTROL

4.1 To ensure proper control of the welding process, it shall be mandatory that the contractor meet all requirements delineated in this document. In addition, it shall be the responsibility of the contractor's Quality organization to audit continually all requirements of this specification to assure compliance.

4.2 Qualification of Welding Equipment: Prior to the use of welding equipment for production purposes, it shall be qualified as a complete system (Paragraph 4.2.4).

4.2.1 Accuracy of meter : All meter indicators of weld energy used for the welding shall have a full-scale accuracy of ± 2% or better and no reading shall be taken below the 15% zone of the low end of the meter.

4.2.2 Repeatability between machines : Machines of the same equipment model shall exhibit ± 5% repeatability with respect to voltage pulse duration, voltage amplitude, and pulse shape at specified settings.

4.2.3 Within-Machine-Repeatability: Within-machine repeatability shall be ± 5% for any specified setting.

4.2.3.1 The voltage waveform at the Weld-Head shall be measured and adjusted if necessary to attain the required pulse duration and amplitude and type of pulse shape at selected settings.

4.2.3.2 The force at the electrodes shall be accurate and repeatable as specified in Paragraph 3.3.1.2.

4.2.4 Qualification of Welding Machines

4.2.4.1 The Quality Control organisation shall specify the ISO weld schedule to be used for Welding Machine qualification. The actual welding machine setting, such as, typical wave shape, amplitude, pulse duration, force and gap shall be recorded on the qualification work sheet prior to and after completion of the qualification test.

4.2.4.2 Amplitude, pulse duration, force, gap and typical wave shape shall meet the requirements of paragraph 3.3.1.

4.2.4.3 During qualification welding, no maintenance or adjustments to the equipment shall be permitted.

4.2.4.4 A minimum sample of 55 weld samples shall be prepared at a specified ISO weld schedule by a qualified welding operator. The weld samples must meet all the visual requirements defined in paragraph 5. Five (5) randomly ~~selected samples~~ must meet the metallurgical requirements defined in Paragraph 5.2. The remaining 50 welds shall be pull tested and meet the statistical requirements of Paragraph 4.9.2.

4.2.5 Records of qualification must carry the following information:

(a) Welding Machine make and serial number.

(b) Class and type of electrodes used during qualification.

(c) Types of materials welded.

(d) Quality Control Engineering approval.

(e) Date of qualification.

(f) Restrictions, if any.

(g) Welding machine settings used.

(h) Welding head serial number.

(i) Visual weld acceptance data.

(j) Duration and amplitude data and type of pulse shape.

4.2.6 The contractor's quality organization shall establish or approve the criteria for qualification of welding machines. These criteria shall include the requirements of this specification as a minimum.

4.3 Qualification of Welding Machine Operators

4.3.5 If an operator fails Qualification, or if Qualification is revoked at any time, the operator shall be retrained and requalified in accordance with the above paragraphs before being permitted to continue production welding.

4.3.5.1 Requalification of an operator shall be required:

(a) If the production supervisor or cognizant Quality Control Agency has evidence that an operator's welding is sub-standard.

(b) If visual inspection results in an abnormal rejection rate of weldments due to an operator's performance or workmanship.

4.3.6 If the operator has not performed parallel gap welding for 30 days or more, she shall prepare daily for a period of not less than five (5) consecutive working days 15 acceptable welds out of 15 attempts manufactured to an approved weld schedule. In addition, she shall weld an acceptable dummy module consisting of 50 welds, all of which shall be acceptable per Para. 5.

4.3.7 The contractor's Quality organization shall establish or approve the criteria for qualification of welding operators. These criteria shall include the requirements of this specification as a minimum. The Quality organization shall have the final approval authority on the eligibility of a candidate for welding operator work.

4.4 Qualification of Inspection Personnel

4.4.1 All Welding Inspectors shall successfully complete both the Operator Training Program and the Inspector Training Program.

4.4.2 The inspector shall demonstrate:

(a) A working knowledge of all inspection criteria and requirements.

(b) The ability to identify a machine setting from a posted weld schedule.

(c) The ability to use 10 x magnification for visual inspection.

(d) Acceptable operation of the pull testing equipment.

(e) The ability to read and understand applicable routing specifications.

4.4.3 The inspector shall inspect, daily for a period of not less than five (5) consecutive working days, 15 welds to demonstrate proficiency in identifying both acceptable and non-acceptable operator performance in accordance with weld defect criteria.

4.7.4.3 "t" Test Comparison of Means: The mean break strength at each of the box points shall be compared with that at the selected schedule by:

$$t = \frac{\bar{X}_s - \bar{X}_B}{\sqrt{\frac{N_s \sigma_s^2 + N_B \sigma_B^2}{N_s + N_B - 2} \cdot \frac{N_s + N_B}{N_s \times N_B}}} \leq 3$$

4.7.4.4 "F" Test Comparison of Variances: The standard deviation at each of the box points shall be compared with that at the selected schedule by:

$$F = \frac{\sigma_B^2}{\sigma_s^2} \leq 2.4$$

4.7.4.5 ISO Strength studies which fail to meet the statistical requirements of Paragraph 4.7.4.1, 4.7.4.2, 4.7.4.3, or 4.7.4.4 may be accepted as an exceptional or unique condition only after the ISO strength data has been computed, analyzed, and an assignable cause has been derived. It shall be the Quality Control functions responsibility for establishing variation limits from the allowable statistical requirements, and assuring the acceptable weld quantity of the ISO strength study and the weld quality of future products which will utilize this weld schedule.

Documented evidence, such as, metallurgical analysis, material strength and variation studies, and statistical test data, must form part of the ISO strength study data package to substantiate the invokement of this paragraph.

4.7.4.6 Exceptional or unique conditions: At times, welding is performed under exceptional of unique conditions. This may result in the establishment of criteria other than those described herein for standard conditions.

4.8 Methods of Performing Break-Strength Test

4.8.1 180° Peel Test. The 180° Peel Test is illustrated in Figure #3A. The load is applied along the axis of the two members, such that a failure will occur by peeling of the weld. The mode of failure will be a tensile fracture through the weld, or a fracture of the lead adjacent to the weld.

4.8.2 Tensile Shear Test. The Tensile Shear is illustrated in Figure #3B. The load is applied axially along both members. The failure mode will depend on the rigidity of the member.

4.9 Weld Process Control

4.9.1 Maintenance. Maintenance of welding equipment used in production shall be performed by qualified set-up personnel prior to production welding and shall include checks for:

(a) Electrode force and gap setting.

(b) Electrode alignment, positioning and dress.

(c) Voltage and pulse duration.

4.9.2 To verify the continued effectiveness of weld schedule information and welding machine and personnel capabilities, statistical process control techniques shall be developed and implemented for use with production welding activity. $\bar{X}$ and R techniques shall be used. Statistical control data may be derived from the samples as prepared in the following paragraphs. Control limits shall be based on data developed during verification of the selected schedule.

4.9.2.1 At least once per shift, prior to production welding, a minimum of 5 weld-test specimens shall be prepared for each active weld schedule setting.

Figure 3A

180° Peel Test

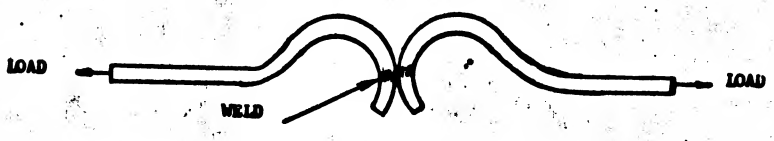
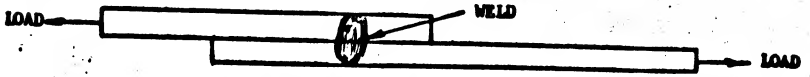


Figure 3B

Tensile Shear Test



4.9.2.2 Weld specimens shall be visually inspected per Para. 5.1 and pull tested to destruction in accordance with Paragraph 4.8.

4.9.2.3 The average pull strength and pull strength range for each sample group shall be utilized for statistical process control purposes.

4.9.2.4 If the sample data, the production operator, or the inspector indicates that the process is out of control, any weldments made since the previous satisfactory sampling shall be considered unsatisfactory until accepted by complete visual reinspection.

4.9.2.5 The Quality organization shall investigate out of control conditions, determine their origin, and initiate the corrective action required.

4.9.3 Calibration of Equipment

4.9.3.1 Welding Machines. Electrical and mechanical accuracy of the equipment shall be recalibrated at least every 60 days by checking all items under Paragraph 4.2.4.

4.9.3.2 Pull Test machines shall be checked for accuracy at intervals not to exceed 60 days.

4.9.3.3 Binocular microscope and electrode force gages shall be calibrated at least every 60 days.

4.9.3.4 All equipment that must be calibrated shall have attached to it a label or tag indicating the date for next calibration.

4.9.3.5 Equipment with calibration past due shall not be used until it has been recalibrated.

4.9.4 A Weld Machine History Record shall be maintained, including a record of all major changes made on each weld machine. Such items as tube and transistor replacements, cable replacements, major overhauls, etc., shall be recorded. All entries shall be clearly dated and initialed.

5. QUALITY ASSURANCE REQUIREMENTS

5.1 Visual Inspection. All production welds shall be inspected visually at 10 x magnification at a work station other than the welding position for the following items: [Paragraph 2.1(a)]

5.1.1 Presence or absence of a weld. If doubt exists as to the presence or absence of a weld, the weld is to be rejected. Under no conditions is a weld to be stressed by any means.

5.1.2 Presence or absence of gross defects. Presence of the following gross defects shall be cause for rejection by the inspector: [Paragraph 2.1 (a).]

(a) Any crack in or fracture of either parent member.

(b) A hole of any size which has been burned through one or both of the parent members.

(c) Any removal of material in the smaller member which reduces the cross sectional area of the member by 20 per cent or more.

(d) Any hole, the internal extent of which is not visually determinable.

(e) Insufficient weld is evident where the leads are insecurely bonded.

5.2 Metallurgical Inspection. Samples from the selected schedule and the four Box-Points shall be examined metallographically at 75 x (or greater) magnification for evidence of satisfactory metallurgical bond. Specimens examined shall conform to the following criteria.

5.2.1 When viewed metallographically, at least 90 per cent of the line of demarcation between the two members shall exhibit a s actory metallurgical bond. Two sections shall be examined at 75 x min. as needed to verify the existence of a satisfactory metallurgical bond. One section shall be longitudinal to the weld, the other shall be transverse to the weld.

5.2.2 Any evidence of porosity, cracks, voids or areas of visible separation located along the interface shall constitute a region of unsatisfactory bond. The total linear dimension of all such regions located at the interface shall under no circumstances exceed 10 per cent of the total length of the line of demarcation between the parent members.

5.2.3 Providing that the strength of the bond meets all test requirements and that at least 90% of the bonding interface exhibits a satisfactory bond, the weld shall be deemed satisfactory unless:

(a) Porosity, voids or cracks are observed at locations other than the weld interface with major dimension exceeding 10 per cent of the thickness of the member in which they are located.

(b) In alloy systems where low melting or brittle phases are possible, metallographic examination reveals such phases to be present and so distributed as to be likely to impair the weld performance.

(c) A continuous network of cast or dendritic structure is present and so distributed as to be likely to impair the performance of the weld under cyclically imposed dynamic loads.

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MD 1002259
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Class Release

PROCESS FOR CONTROL AND FABRICATION OF SIGNAL LAYER MATRIX ASSEMBLIES

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Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA
(M) 23 Nov 1965	A	24202	2, 3, 4 & 5	EGI	JAR

This specification consists of pages 1 to 5 inclusive.

APPROVALS			
	A. L. Mc V NASA/MSC	C M Levenson W Hopkins 12/24/65 MIT/IL	A. Hymese Charles Ramp RAY

RAY

3.3 Configuration. The configuration of the matrix assembly shall be in accordance with applicable assembly drawing.

3.4 Electrical. The matrix assembly shall meet the following electrical requirements.

3.4.1 Continuity. The matrix assembly shall exhibit less than a 4 ohm resistance (.5 ohm attributable to the signal layer under test and balance of 3.5 ohms to test fixturing) for any continuous circuit path under test as defined by appropriate wiring diagram references when tested per par. 4.1.2.1.

3.4.2 Insulation Resistance. The matrix assembly shall evidence no dielectric breakdown between isolated circuit paths, as defined by the appropriate wiring diagram references, when subjected to 100 volts D.C. minimum and tested per paragraph 4.1.2.2.

3.5 Temperature Resistance. The matrix assembly when subjected to a temperature of 125°C ± 2°C for two hours minimum shall meet the electrical requirements of paragraph 3.4.

3.6 Process Requirements

3.6.1 Mold Preparation. Molds used shall be clean and free of grease, oil, dirt, or other contamination. Mold shall be coated with mold release agent which in no way shall have a deleterious effect on the matrix assembly before, during, or after curing, and which shall allow releasing of the cured assembly from the mold without damage.

3.6.2 Assembly of Signal Layers.

3.6.2.1 Signal layers shall be either Type I - punched or Type II - etched per ND 1002262. Only one type shall be used in each matrix.

3.6.2.2 Using suitable fixture with locating pins, central locating groove, and serrated grooves for positioning of matrix leads, lay a strip of double coated insulation tape 1006806-18 in the center groove. Remove top paper liner to expose tape adhesive. Alignment of various layers of tape shall be in accordance with the applicable drawing.

3.6.2.3 Position signal layer on fixture with pins passing through locating holes of signal layer.

3.6.2.4 Position tape 1006806-17 over signal layer, locating it centrally in the groove, with adhesive side up.

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PROCESS FOR CONTROL AND FABRICATION OF MATRIX ASSEMBLIES

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA

This specification consists of pages 1 **to** 5 **inclusive.**

APPROVALS	NASA/MSC	MIT/IL 7/2/68	RAY

PROCESS FOR CONTROL AND

FABRICATION OF MATRIX ASSEMBLIES

1. SCOPE

1.1 This document establishes the requirements for process control and fabrication of matrix assemblies (Dwgs 2003030 and 2007100) to be used in Apollo Guidance Computer.

1.2 The matrix assemblies consist of "signal layers" of nickel, machine stamped from nickel strip to the required network configuration, which are positioned as layers in a plastic case or envelope and insulated from each other with mylar tape.

2. APPLICABLE DOCUMENTS

2.1 The following documents form a part of this specification to the extent specified herein.

DRAWINGS

NASA -

2003030	Matrix Assembly, Logic Module
2007100	Matrix Assembly, CDU Logic Module
2004048	Shim, Matrix Assembly
2004049	Cover, Matrix Assembly
2004050	Envelope, Matrix Assembly
1006806	Insulation Tape, Electrical

SPECIFICATIONS

Federal -

BB-F-671	Freon T. F.

3. REQUIREMENTS

3.1 Unless otherwise specified, a preproduction sample shall meet all the requirements of this specification.

3.2 Materials of construction. Materials shall be used that will produce reliable matrix assemblies and shall be in accordance with Dwgs 2003030 or 2007100 as applicable.

3.3 Configuration. The configuration of the matrix assembly shall be in accordance with Dwg. 2003030 or Dwg. 2007100 as applicable.

3.4 Electrical. The matrix assembly shall meet the following electrical requirements.

3.4.1 Continuity. The matrix assembly shall exhibit less than a 4 ohms resistance for any continuous circuit path under test, as defined by the appropriate wiring diagram references of 2003030 and 2007100.

3.4.2 Insulation Resistance. The matrix assembly shall evidence no dielectric breakdown between isolated circuit paths, as defined by the appropriate wiring diagram references of 2003030 and 2007100, when subjected to 500 volts D.C. and tested per paragraph 4.1.2.2.

3.5 Temperature Resistance. The matrix assembly when subjected to a temperature of $125^{o}C \pm 2^{o}C$ for two hours minimum shall meet the electrical requirements of paragraph 3.4.

3.6 Process Requirements

3.6.1 Mold Preparation. Molds used shall be clean and free of grease, oil, dirt, or other contamination. Mold shall be coated with mold release agent which in no way shall have a deleterious effect on the matrix assembly before, during, or after curing, and which shall allow releasing of the cured assembly from the mold without damage.

3.6.2 Assembly of Signal Layers.

3.6.2.1 Using suitable fixture with locating pins, central locating groove, and serrated grooves for positioning of matrix leads, lay a strip of double coated insulation tape 1006806-18 in the center groove. Remove top paper liner to expose tape adhesive.

3.6.2.2 Position signal layer on fixture with pins passing through locating holes of signal layer.

3.6.2.3 Position tape 1006806-17 over signal layer, locating it centrally in the groove, with adhesive side up.

3.6.2.4 Repeat steps 3.6.2.2 and 3.6.2.3 for the required number of layers, using double coated tape 1006806-18 as final top layer. After final layer, press assembly firmly to achieve adhesion.

3.6.2.5 Using suitable bending fixture, bend signal layers to required configuration for insertion of assembly into plastic envelope.

3.6.3 Formation of Plastic Envelope.

3.6.3.1 Coat with fluorocarbon base mold release a mold suitable for forming plastic envelope to required shape and dimensions.

3.6.3.2 Place preimpregnated glass cloth per dwg 2004050 in coated mold.

3.6.3.3 Form the envelope to a permanent set by heating at $180^{\circ}F \pm 5^{\circ}F$ for 15 to 20 minutes and cooling to room temperature. Remove envelope from mold.

3.6.4 Final Assembly of Matrix

3.6.4.1 Coat groove section of a suitable mold with fluorocarbon base mold release, masking off area on either side of groove to prevent coating of mold release on those areas which will come in contact with the signal wire leads. After mold release dries, remove the masking.

3.6.4.2 Place plastic envelope formed in par 3.6.3 in 3.6.4.1 mold.

3.6.4.3 Place required number of shims per dwg 2004048 in bottom of plastic envelope.

3.6.4.4 Remove paper liner from underside of signal layer assembly (see 3.6.2) and position in plastic envelope over shims.

3.6.4.5 Remove paper liner from top side of 3.6.4.4 assembly, and place a strip of mylar film over it to act as a mold release.

3.6.4.6 Position glass cloth preimpregnated cover, dwg 2004049, over mylar film.

3.6.4.7 Close mold, exerting slight contact pressure on the assembly.

3.6.4.8 Cure assembly at $300^{\circ}F \pm 5^{\circ}F$ for 1 hour minimum.

3.6.4.9 Allow to cool to room temperature and remove assembly from mold.

3.6.4.10 Clean signal wires with Freon T.F.

NOTE: This is only a precautionary step prior to welding because there should be no mold release on the signal wires if masking in 3.6.4.1 is carried out properly.

4. QUALITY ASSURANCE PROVISIONS

4.1 Examination

4.1.1 Visual examination of matrix assemblies shall be conducted on 100% of production as follows.

4.1.1.1 Dimensions shall be as specified in dwg 2003030 or 2007100 as applicable.

4.1.1.2 Workmanship. Visually examine matrix assembly for damage such as nicks, cuts, or gouges which would expose the nickel conductors within the plastic envelope and cover, and for damage such as broken or severely bent nickel conductors that are outside the plastic envelope. Any such damage shall be cause for rejection.

4.1.2 Examination Testing. Examination testing shall be conducted on 100 per cent of production as follows for continuity and insulation resistance and on the preproduction sample plus every 250th production matrix for temperature resistance.

4.1.2.1 Continuity. The continuity of each signal layer shall be measured and verified by means of appropriate circuit analysis and meet the requirements as specified in paragraph 3.4.1.

4.1.2.2 Insulation Resistance. With a voltage of 500 volts applied between conductors and outside bottom of the plastic envelope, the matrix assembly shall meet the requirements of paragraph 3.4.2. Resistance measurements of less than 30 megohms shall be cause for rejection.

4.1.2.3 Temperature Resistance. Heat matrix assembly to a temperature of $125^{\circ}C \pm 2^{\circ}C$, and after holding at temperature for 2 hours minimum, the matrix assembly shall meet the requirements of paragraph 3.4. After cooling to room temperature, the assembly shall meet the dimensional requirements of Dwg. 2003030 or 2007100 as applicable.

5. NOTES

5.1 Intended use. The matrix assemblies are intended for use in Module Assemblies in the Apollo Guidance Computer.

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PROCESS SPECIFICATION FOR SPECIAL CONDITIONING OF INTEGRATED SENSE AMPLIFIERS

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11/2/65	A	23613	4	WK	A. C. METZGER

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3.3.2.6 Helium Leak Test (Test #5)

The helium leak test shall be performed in accordance with ND 1002246 using a leak rate of 1×10^{-6} cc/ATM/SEC as the upper limit in accordance with MIL/STD/202, method 112, test condition C.

3.3.2.7 Glycerine Bubble Test (Test #6)

The oil bubble test for gross leaks shall be performed in accordance with MIL-202C method 112, test condition A except that glycerine shall be used.

3.3.2.8 High Temperature Bake Test (Test #7)

The high temperature bake test shall be performed in accordance with Specification Control Drawing 1006769 for 250 hours at 150 degrees centigrade minimum.

3.3.2.9 Centrifuge Y_1 Test (Test #8)

The centrifuge Y_1 test shall be performed with an accelerator of 20,000 G in accordance with MIL/STD/750 method 2006. Plane Y_1 is defined as a force attempting to push the internal lead wires toward the "top" of the device.

3.3.2.10 Operation Life Test (Test #10)

The operation life test shall be performed in accordance with MIL-STD-750, method 1026 and Specification Control Drawing 1006769 except that the time shall be 150 ± 5 hours.

3.3.2.11 Vibration Test (Test #11)

The vibration test shall be performed on a random sample of 5 units. The vibration test shall be performed in accordance with MIL-STD-750, method 2056, 30 G's from 5 to 2000 CPS limited to 0.12 inch double amplitude, 3 cycles, 15 minutes per cycle minimum.

3.3.2.12 Shock Test (Test #12)

The shock test shall be performed on the same units tested in 3.3.2.11. The shock test shall be performed in accordance with MIL-STD-750, method 2016, 1500 G's, 0.5 m. sec, 5 blows in all axis directions, 30 blows total.

3.3.2.13 Continuity Test (Test #13)

The continuity test shall be performed on the five sample units from test #12 only. The test shall be performed to detect open bonds and shorts between leads, leads and case and leads and chip. Upon completion, the units will be sent to Internal Visual, Test #15.

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PROCESS SPECIFICATION FOR SPECIAL CONDITIONING OF INTEGRATED SENSE AMPLIFIERS

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			14		

Sheet 1 thru 14

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If the number of unit failures allowable is calculated to be a mixed number, a combination of an integer and a fraction, use the integer only.

TABLE II

Test Number (See Paragraph 3.3.1)	Maximum Percent of Failures or Maximum Allowable Rejects
2	1 defective unit, Physical Dimensions
2	1 defective unit, Lead fatigue and tension
5	Helium Leak 2.0 %
6	Glycerine Bubble 2.0 %
15	Internal Visual 1 unit

4.3 Rejection Criteria

4.3.1 Lot Rejection

The failures of a shipment lot shall be classified as specified in 4.2.2 such that the failures can be identified with the groupings specified in 4.2.3. The maximum allowable percentages of failures from test number 3,9, and 14 of paragraph 3.3.1 according to the failure mode groupings of 4.2.3 are given in Table I. The maximum allowable percentages of failures from test numbers 2,5,6, and 15 of paragraph 3.3.1 are given in Table II where the failure definitions are given in 6.2. Failure to meet any one of the maximum allowable percentages of Tables I and II or failure to comply with the test sequence of 3.3.1, the test procedure 3.3.2, the flight qualification requirements of 4.4, or the data requirements of 4.5 shall be cause for lot rejection.

4.3.1.1 Conformance to ND 1015404

Disclosure of any violation of previously agreed to contractor-supplier ND 1015404 "Critical Process" list without prior notification automatically fails the entire lot. Notice of such deviation must be made by the contractor to MIT/IL within 24 hours of disclosure.

4.3.2 Sub-lot removal

If the reason for shipment lot rejection can be assigned to failure modes which are traceable to a diffusion sublot, the entire diffusion sub-lot(s) shall be removed from the shipment lot and the provisions of paragraph 4.3.1 shall be reapplied to the remainder of the shipment lot. For example, failure modes which are traceable to diffusion sub-lot(s) are described in paragraph 4.2.2 sub-paragraphs a1, a13, b4, b8, b9, q2, and c4.

4.4 Flight Qualification

4.4.1 Flight Qualified Hardware

An integrated sense amplifier is flight qualified when

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PROCESS SPECIFICATION FOR SPECIAL CONDITIONING OF INTEGRATED SENSE AMPLIFIERS

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PROCESS SPECIFICATION FOR SPECIAL CONDITIONING OF INTEGRATED SENSE AMPLIFIERS

I Scope

1.1 Purpose

This specification establishes the minimum requirements for the acceptance of integrated sense amplifiers for use in flyable deliverable end items. The procedure described herein shall be performed by the G & N Industrial Contractor as part of incoming inspection, screen and burn-in.

II Applicable documents

2.1 Effective Issues

The following documents of the issue in effect on the date of this document form a part of this specification to the extent specified herein.

Specification

MIL-STD-750 - TEST METHODS FOR SEMI-CONDUCTOR DEVICES.
MIL-STD-202 - TEST METHODS FOR ELECTRONIC AND ELECTRICAL COMPONENT PARTS.

Apollo G & N

ND 1002017 - DESCRIPTION AND TEST REQUIREMENTS FOR SENSE AMPLIFIER.
ND 1002257 - INTERNAL VISUAL REJECTION CRITERIA FOR INTEGRATED CIRCUITS.

Drawing

Apollo G & N - SPECIFICATION CONTROL DRAWING FOR INTEGRATED
SCD 1006769 SENSE AMPLIFIERS.

Reports

MIT/IL E-1679 - PROGRESS REPORT ON ATTAINABLE RELIABILITY OF INTEGRATED CIRCUITS FOR SYSTEM APPLICATION.

III Requirements

3.1 General

The provisions of this specification shall be applicable to all phases of acceptance of integrated sense amplifiers to the extent specified herein. Specific requirements or provisions not

covered by this specification shall be as specified on the applicable drawing or purchase order. In the event of conflict between the requirements of the applicable drawing, this specification and other documents cited herein, the requirements of the applicable drawing and this specification shall govern in that order.

3.2 Process Control

The process covered by this specification shall be controlled in accordance with the process control provision of 4.2.

3.2.1 Lot Control

Each lot as supplied by the vendor in compliance with 1006769 shall be identified and maintained by the contractor throughout the test sequence, 3.3.1.

3.2.2 Serialization

All units of a lot shall be identified by the lot number and the unit serial number.

3.3 Test Procedure

3.3.1 Test Sequence

a. External visual inspection (Test #1)
b. Physical dimension, lead tension and fatigue inspection (Test #2)
c. Electrical test (Test #3)
d. Thermal Cycle test (Test #4)
e. Helium leak test (Test #5)
f. Glycerine bubble test (Test #6)
g. High temperature bake test (Test #7)
h. Centrifuge Y_1 test (Test #8)
i. Electrical test (Test #9)
j. Operation life test (Test #10)
k. Vibration test (Test #11)
l. Shock test (Test #12)
m. Continuity test (Test #13)
n. Electrical test (Test #14)
o. Internal visual (Test #15)

3.3.1.1 Removal of Failures

Catastrophic failures only shall be removed from the test sequence at the point of detection and subjected to failure analysis.

The point in the test sequence 3.3.1 where the failure was detected must be recorded and a set of electrical readings as specified in Paragraph 3.3.2.3 shall be performed. All electrical failures at the end of test sequence 3.3.1 shall be subjected to failure analysis except the incoming marginal failures as defined in (6.2.3 (a).) may be returned to the vendor.

3.3.2 Tests

3.3.2.1 External Visual Inspection (Test #1)

Each lot of integrated sense amplifiers shall be subjected to an external visual inspection in accordance with MIL-STD-750, method 2071 and Specification Control Drawing 1006769.

3.3.2.2 Physical Dimension, Lead Tension and Fatigue (Test #2)

Three samples from each lot of integrated sense amplifiers shall be subjected to the physical dimension examination of MIL-STD-750, method 2066 and the requirements of Specification Control Drawing 1006769. The three units subjected to the lead tension and lead fatigue tests are to be forwarded to Test #15 of sequence 3.3.1.

3.3.2.3 Electrical Test (Test #3)

The entire lot shall be subjected to electrical test as described in Specification Control Drawing 1006769 and ND 1002017 with the limits specified. Acceptance parameters are gain measurements, resolution, voltage ratio, differential offset, leakage measurements, gate operation, response time parameters, propagation delay and fall time and turn-off time.

3.3.2.4 Electrical Test (Tests #9 and #14)

The electrical test shall be the same as performed in 3.2.2.3 except that the maximum limits as defined in Specification Control Drawing 1006769 and ND 1002017 shall be raised 1% and the minimum limit decreased 1%.

3.3.2.5 Thermal Cycle Test (Test #4)

Three complete cycles shall be performed on the lot under the following conditions.

STEP	TEMPERATURE °C	TIME
1	150 ± 5° C	30 minutes
2	25 ± 5° C	*N.M.T. 10 seconds
3	-65 ± 5° C	30 minutes
4	25 ± 5° C	*N.M.T. 10 seconds

* Not more than-Transfer Time

3.3.2.6 Helium Leak Test (Test #5)

The helium leak test shall be performed in accordance with ND 1002246 using a leak rate of 1×10^{-6} cc/ATM/SEC as the upper limit in accordance with MIL/STD/202, method 112, test condition C.

3.3.2.7 Glycerine Bubble Test (Test #6)

The oil bubble test for gross leaks shall be performed in accordance with MIL-202C method 112, test condition A except that glycerine shall be used.

3.3.2.8 High Temperature Bake Test (Test #7)

The high temperature bake test shall be performed in accordance with Specification Control Drawing 1006769 for 250 hours at 150 degrees centigrade minimum.

3.3.2.9 Centrifuge Y_1 Test (Test #8)

The centrifuge Y_1 test shall be performed with an accelerator of 20,000 G in accordance with MIL/STD/750 method 2006. Plane Y_1 is defined as a force attempting to push the internal lead wires toward the bottom of the device.

3.3.2.10 Operation Life Test (Test #10)

The operation life test shall be performed in accordance with MIL-STD-750, method 1026 and Specification Control Drawing 1006769 except that the time shall be 150 ± 5 hours.

3.3.2.11 Vibration Test (Test #11)

The vibration test shall be performed on a random sample of 5 units. The vibration test shall be performed in accordance with MIL-STD-750, method 2056, 30 G's from 5 to 2000 CPS limited to 0.12 inch double amplitude, 3 cycles, 15 minutes per cycle minimum.

3.3.2.12 Shock Test (Test #12)

The shock test shall be performed on the same units tested in 3.3.2.11. The shock test shall be performed in accordance with MIL-STD-750, method 2016, 1500 G's, 0.5 m. sec, 5 blows in all axis directions, 30 blows total.

3.3.2.13 Continuity Test (Test #13)

The continuity test shall be performed on the five sample units from test #12 only. The test shall be performed to detect open bonds and shorts between leads, leads and case and leads and chip. Upon completion, the units will be sent to Internal Visual, Test #15.

3.3.2.14 Internal Visual Inspection (Test #15)

The internal visual inspection shall be performed on the 3 units sent from paragraph 3.3.2.2 (Test #2). In accordance with ND 1002257 and the five units from paragraph 3.2.2.13 (Test #13).

IV Quality Assurance Provisions

4.1 General

In order to assure proper control of the acceptance process covered by this specification, the contractor shall meet all the requirements specified herein and shall provide continuous audit of the acceptance process to assure compliance with the requirements of this specification.

4.1.1 Inspection

The contractor, through his quality assurance or control agency shall be responsible for the performance of all inspection requirements and tests specified herein.

4.2 Failure Criteria

4.2.1 Failure Analysis

All integrated sense amplifiers failing in the electrical tests specified in 3.3.2 (Test #3, 9, 14) except the non-catastrophic failures as defined in 6.2.3 (a,b,c, and e), shall be subjected to a failure analysis sufficient to identify cause and mode of failure. For failure definitions refer to Section 6.2.

4.2.2 Failure Modes

After failure analysis all failures detected at test 3, 9, and 14 of test sequence 3.3.1, except induced failures and non-catastrophic failures as defined in 6.2.3 (a,b,c, and e), shall be classified as to the following failure modes which are described in MIT/IL report E-1679.

a. Class A failure modes (class A failure modes are generally of a type readily weeded out during screen and burn-in).

1. Open bonds due to poor metalization adhesion to the silicon dioxide.

2. Open bonds due to underbonding.

3. Open bonds due to gold-aluminum eutectic formation.

4. Open bonds due to overbonding.

5. Opens due to nicks and cuts in the bonding wire.

6. Leads shorting to the edge of the chip or leads shorting to the package lid.

7. Open interconnects detected only during test 3.3.2.3 due to only scratches with no evidence of metalization corrosion at the open.

8. Shorts due to metalization scratching and smearing.

9. Shorts induced by the collector to emitter sustaining voltage test of paragraph 3.3.2.3.

10. Failures due to cracked chip.

11. Opens due to the thinning of lead wire due to poor bonding procedure.

12. Non-catastrophic failures due to surface instabilities that are not included in 6.2.3 (a,b,c and e).

b. Class B failure modes (class B failure modes are of a type less readily detected during screen and burn-in as compared with class A).

1. Shorts resulting from leads touching any other leads and shorts resulting from leads touching metal interconnects.

2. Opens in the interconnect due to the gold-aluminum eutectic formation at the neck of an interconnect.

3. Shorts through the silicon dioxide due to poor oxide dielectric strength.

4. Shorts through the oxide because the bonds are too close to the chip edge.

5. Shorts, intermittent or otherwise, due to particles in the package.

6. Shorts, intermittent or otherwise, due to free lead material and fixed extra leads or lead material.

7. Catastrophic failures due to surface instabilities.

8. Opens in interconnect at oxide steps detected during test 3.3.2.3.

c. Class C failure modes (class C failure modes are of a type which are time dependent and/or are not easily detected during screen and burn-in).

1. Opens in the interconnect due to corrosion.

2. Opens in the interconnect detected after test 3.3.2.3 at oxide steps.

3. Opens in the interconnect detected after test 3.3.2.3 at scratches.

4. Any failures due to electrically insulating or electrically high resistance layers forming at the silicon oxide window between the metal contact and the silicon or between the layers of metal.

5. Die separated from package header.

4.2.3 Failure Mode Grouping

4.2.3.1 Classification

Following the classification of failure modes from a lot the electrical failures will be divided into Group I - IV below and the percentage failure for the lot in each group shall be determined. Group O contains special cases of non-catastrophic failures.

a. Group O. Test #3

Non-catastrophic failures as defined in 6.2.3 (a)

b. Group O. Test #9 #11

Non-catastrophic failures as defined in 6.2.3 (b, and c).

c. Group I. Class A failure modes.

d. Group II. Class B failure modes.

e. Group III. Class C failure modes.

f. Group IV. Any failure, except induced failures, not listed in Section 4.3.2 or any failure for an unknown cause.

TABLE I

Test Number	*Maximum Percent of Failures				
(See Para. 3.3.1)	Group O	Group I	Group II	Group III	Group IV
3	5.0 %	1.0 %	1.0 %	0.2 %	0 %
9, 11, and 14	1.00%	1.0 %	0.2 %	0 %	0 %

If the number of unit failures allowable is calculated to be a mixed number, a combination of an integer and a fraction, use the integer only.

Test Number (See Paragraph 3.3.1)	Maximum Percent of Failures or Maximum Allowable Rejects
2	1 defective unit, Physical Dimensions
2	1 defective unit, Lead fatigue and tension
5	Helium Leak 2.0 %
6	Glycerine Bubble 2.0 %
15	Internal Visual 1 unit

4.3 Rejection Criteria

4.3.1 Lot Rejection

The failures of a shipment lot shall be classified as specified in 4.2.2 such that the failures can be identified with the groupings specified in 4.2.3. The maximum allowable percentages of failures from test number 3,9, and 14 of paragraph 3.3.1 according to the failure mode groupings of 4.2.3 are given in Table I. The maximum allowable percentages of failures from test numbers 2,5,6, and 15 of paragraph 3.3.1 are given in Table II where the failure definitions are given in 6.2. Failure to meet any one of the maximum allowable percentages of Tables I and II or failure to comply with the test sequence of 3.3.1, the test procedure 3.3.2, the flight qualification requirements of 4.4, or the data requirements of 4.5 shall be cause for lot rejection.

4.3.1.1 Conformance to ND 1015404

Disclosure of any violation of previously agreed to contractor-supplier ND 1015404 "Critical Process" list without prior notification automatically fails the entire lot. Notice of such deviation must be made by the contractor to MIT/IL within 24 hours of disclosure.

4.3.2 Sub-lot removal

If the reason for shipment lot rejection can be assigned to failure modes which are traceable to a diffusion sublot, the entire diffusion sub-lot(s) shall be removed from the shipment lot and the provisions of paragraph 4.3.1 shall be reapplied to the remainder of the shipment lot. For example, failure modes which are traceable to diffusion sub-lot(s) are described in paragraph 4.2.2 sub-paragraphs a1, b4, b8, c2, and c4.

4.4 Flight Qualification

4.4.1 Flight Qualified Hardware

An integrated sense amplifier is flight qualified when

the lot, of which the integrated sense amplifier is part, is not rejected according to 4.3 and the sense amplifier does not fail any test of the test sequence of paragraph 3.3.1.

4.4.1.1 Failure Traceability

Any integrated sense amplifier failure detected in qualified flight hardware must be traceable to a lot as identified in paragraph 3.2.1 and to the unit serial number.

4.4.2 Qualification Report

Two copies of a report justifying the acceptance or rejection of a lot as flight qualified shall be forwarded to MIT/IL prior to use in deliverable end items. The report shall include the following:

a. A summary of screen and burn-in data.

b. A detailed list of the screen and burn-in results which includes the number of failures at each test station of test sequence 3.3.1.

c. A failure report of all electrical failures, by unit serial number including induced failures, as specified in 4.3.1 which includes:

 1. Photographs of each photographable failure mode.

 2. Analysis of each failure.

 3. Classification of each failure according to 4.3.2.

 4. All electrical test data of each failure.

d. Number of failures in the failure mode groups according to 4.2.3.

e. Date of purchase.

f. Total number of ordered parts.

g. Date code of parts received.

h. Lot identification number.

i. Allocation of all parts from the lot updated to the date of issue of qualification report indicating the number of units which passed screen and burn-in, the number of failed units, the number of induced failures and the number of units removed from the lot for any other reason.

j. A report by lot of all internal visual inspection failures (Test #15) (in test sequence 3.3.1) by unit serial number which includes:

 1. Photograph of each failure mode.
 2. Classification of each failure according to ND 1002257.

k. Copies of all contractor approved changes and notification of proprietary supplier changes per ND 1015404.

4.5 Data

4.5 Data Storage

Incoming inspection, screen and burn-in data shall be maintained and stored by lot number and unit serial number for three years.

4.5.1 Cataloging

Integrated sense amplifiers failing the tests specified herein with the exception of the external visual inspection and leak tests shall be cataloged and stored by lot number and serial number for three years. The devices must be readily accessible for future reference.

4.5.2. Lot Storage

Units submitted to the contractor as part of the Quality Demonstration Test shall be stored by contractor's lot number for three years. The devices must be readily accessible for future reference.

V Preparation for Delivery

This section is not applicable to this specification.

VI Notes

6.1 Intended Use

This process conditions nor gates used in Apollo Guidance and Navigation Equipment.

6.2 Definitions

6.2.1 Lot

A shipment lot is defined as a group of integrated sense amplifier submitted by a vendor in compliance with 1006769.

6.2.2 Catastrophic Failures

A catastrophic failure is defined as any device which fails the electrical tests of Specification Control Drawing 1006769 and ND 1002017 by twice the maximum or one half the minimum limits of that table.

6.2.3 Non-Catastrophic Failures

A non-catastrophic failure is any device which cannot be classed as a catastrophic failure by definition 6.2.2 but

which fails according to the definitions described below:

a. A non-catastrophic failure at test 3.3.2.3 exceeds the limits of Specification Control Drawing 1006769 and ND 1002017 and does not become a catastrophic failure during test sequence 3.3.1.

b. A non-catastrophic failure at test 3.3.2.4 exceeds the limits described in 3.3.2.4 but does not change parametric readings obtained in 3.3.2.3 by ± 15%.

c. A non-catastrophic failure at test 3.3.2.4 does not exceed the limits described in 3.3.2.4 but changes parametric readings obtained in test 3.3.2.3 by more than ±15%.

d. A non-catastrophic failure at test 3.3.2.4 can exceed the limits described in 3.3.2.4 and changes parametric readings obtained in test 3.3.2.3 by more than ±15%.

6.2.4 Induced Failures

An induced failure is a catastrophic failure which through failure analysis can be proven to be caused by exceeding the stress limits of Specification Control Drawing 1006769.

6.2.5 Leak Test Failures

A failure at test 5 or 6 of paragraph 3.3.1 is failure to meet the leak rate therein. A failure at test 6 of paragraph 3.3.1 is the failure to meet the criteria as specified in ND 1002246.

6.2.6 External Visual Inspection Failures

A failure at test 1 of paragraph 3.3.1 is failure to meet the visual and mechanical examination criteria of Specification Control Drawing 1006769 and additional requirements negotiated with the applicable vendor.

6.2.7 Physical Dimension Failures

A physical dimension failure of test 2 of paragraph 3.3.1 is a package which does not meet the physical dimension criteria of Specification Control Drawing 1006769.

6.2.8 Lead Tension, Lead Fatigue Failures

The lead tension, lead fatigue failures of test 2 of paragraph 3.3.1 is a partial or complete severing of a lead from the package.

6.2.9 Failures

Failure of a unit in one or more tests will be charged as a single failure. A unit which could be classed by several

failure modes shall be classed in the highest alphabetical mode as listed in 4.2.2. A unit which meets the definition of 6.2.3 (a,b,c and e) shall be counted in Group 0 only.

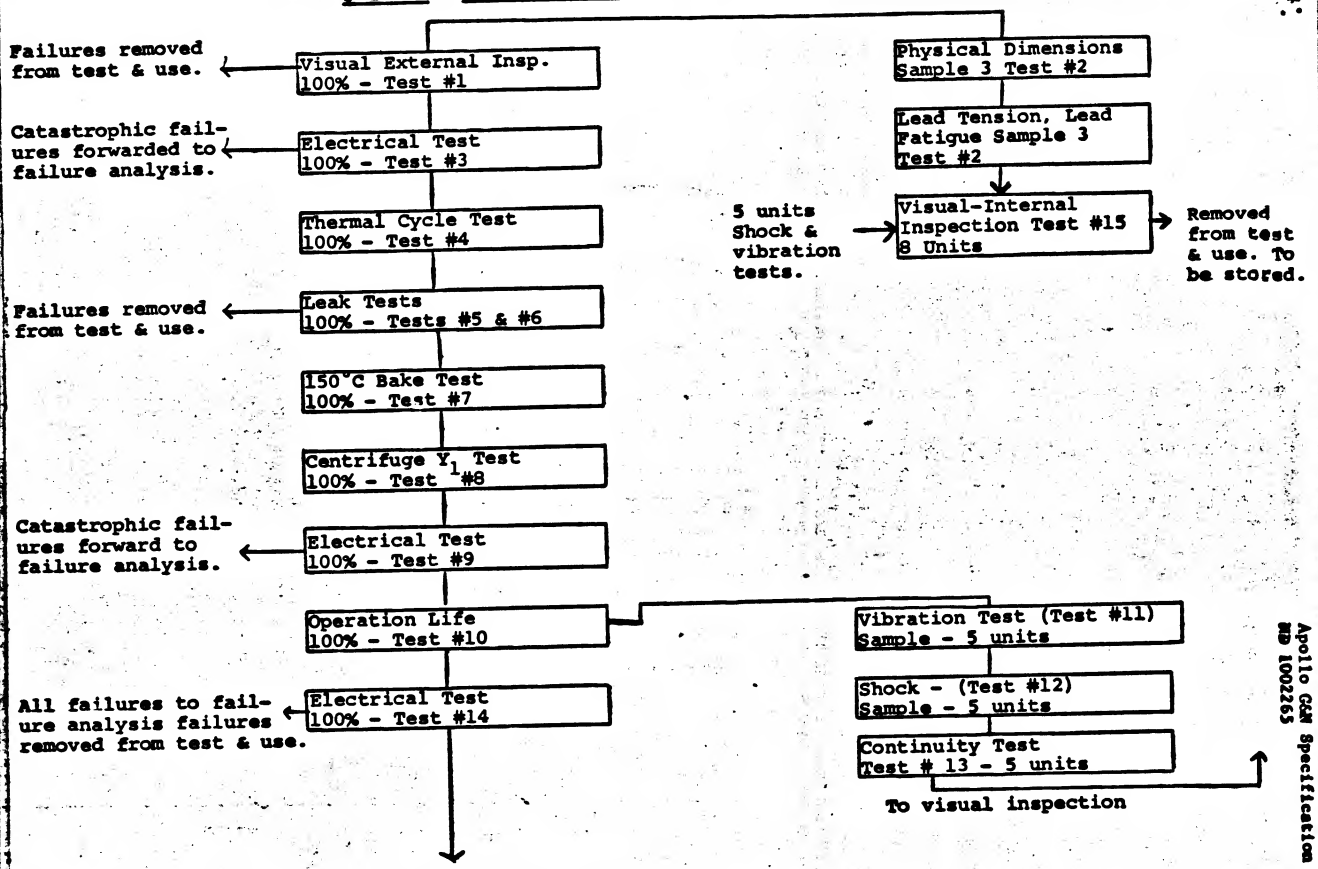
6.2.10 Internal Visual Inspection Failures

A failure at test #15 of paragraph 3.3.1 is a failure to meet the criteria of MD 1002257.

6.2.11 Continuing Failure

A failure of the continuity test is the detection of an open or a short.

Flow Diagram of Sequence 3.3.1



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ND 1002266
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PROCESS SPECIFICATION
SPECIAL CONDITIONING OF TRANSISTORS

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11/1	A	23590	1, 2, 4, 8,	WK	A. C. METZGER

This specification consists of pages 1 to 14 inclusive and cover sheet.

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		Edward Hall 6/15/65	W Kaplan 28 Jun 65		

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PROCESS SPECIFICATION
SPECIAL CONDITIONING OF TRANSISTORS

1. SCOPE

1.1 PURPOSE

This specification establishes the minimum requirements for the acceptance of transistors SCD 1006310 and SCD 1006323 for use in flyable, deliverable end items. The procedure described herein shall be performed by the G&N Industrial Contractor as part of the incoming inspection, screen and burn-in.

2. APPLICABLE DOCUMENTS

2.1 EFFECTIVE ISSUES

The following documents of the issue in effect on the date of this document form a part of this specification to the extent specified herein.

SPECIFICATIONS

Military

MIL-STD-202C	Test methods for electronic and electrical component parts.
MIL-STD-750	Test methods for semiconductor devices.

DRAWINGS

Apollo G&N

1006310	Transistor, silicon, type PNP, switching.
1006323	Transistor, silicon, type NPN, switching.
2004165	Insulator, Transistor
1006355	Curing agent, low viscosity amine type.
1006356	Epoxy resin, low viscosity.

3. REQUIREMENTS

3.1 GENERAL

The provisions of this specification shall be applicable to all phases of acceptance of transistors to the extent specified herein. Specific requirements or provisions not covered by this specification shall be as specified on the applicable drawing or purchase order. In the event of conflict between the requirements of the applicable drawings, this specification and other documents cited herein, the requirements of the applicable drawings, this specification and the other documents specified herein shall govern in that order.

3.1.1

All transistors supplied to this specification must have in-

sulators fabricated from 2004185 affixed to the lead underside of the can utilizing curing agent SCD 1006355 and epoxy resin SCD 1006356.

NOTE: Transistors must have insulators affixed prior to test sequence 3.3.1.g.

3.2 PROCESS CONTROL

The process covered by this specification shall be controlled in accordance with the process control provisions of 4.2.

3.2.1 Lot Control

Each lot (6.2.1) as supplied by the vendor in compliance with 1006310 or 1006323 shall be identified and maintained by the contractor throughout the test sequence, 3.3.1.

3.3 TEST PROCEDURES

3.3.1 Test Sequence

Each lot of transistors shall be subjected to tests in the following sequence:

a. External Visual Inspection (Test #1)

b. Physical Dimension, Lead Tension, and Fatigue Inspection (Test #2)

c. Electrical Test (Test #3)

d. Thermal Cycle Test (Test #4)

e. Helium Leak Test (Test #5)

f. Glycerine Bubble Tests (Test #6)

g. High Temperature Bake Test (Test #7)

h. Centrifuge Y_1 Test (Test #8)

i. Electrical Test (Test #9)

j. Emitter-base back bias Test (Test #10)

k. Gain Measurement (Test #11)

m. Operation Life Test (Test #12)

n. Electrical Test (Test #13)

o. Internal Visual Inspection (Test #14)

A flow diagram of the above sequence is attached.

Collector-emitter saturation voltage at 150 ma
DC Current Gain at 10 ma
DC Current Gain at 150 ma
Emitter-base breakdown voltage
Collector-emitter threshold current
Collector-emitter breakdown voltage
Base-emitter saturation voltage at 500 ma
Collector-emitter sustaining voltage.

Turn-on, turn-off time is to be performed on a 10% sample basis to the limits and conditions specified in Specification Control Drawing 1006323.

3.3.2.4 Electrical Test (Test #9 and #13 of 3.3.1)

a. PNP-SCD 1006310

The entire lot except the devices used in 3.3.2.2 shall be subjected to the following test in the given order:

The tests shall be the same as those outlined in 3.3.2.3 (a) but shall omit the collector-emitter sustaining voltage from the sequence. The limits for the test shall be 4% higher than the maximum and 4% lower than the minimum limits as specified in Specification Control Drawing 1006310.

b. NPN-SCD 1006323

The entire lot except the devices used in 3.3.2.2 shall be subjected to the following tests in the given order:

The tests shall be the same as those outlined in 3.3.2.3 (b) but shall substitute the collector-emitter saturation voltage at 500 ma for the collector-emitter sustaining voltage in the sequence. The limits for the test shall be 4% higher than the maximum and 4% lower than the minimum limits as specified in Specification Control Drawing 1006323.

8. Open bonds detected after first electrical test due to formations of intermetallic compounds of aluminum and gold.

9. Emitter to base shorting detected after first electrical test due to bonds making contact to each other.

10. Open bonds for any cause detected after first electrical test where a substance has been put over the bonds and this substance was the only means of making electrical contact.

GROUP III

1. Any failures, except induced failures, not listed above or any failure for an unknown cause.

TABLE I

Test Number (See Para.3.3.1)	*Maximum Percentage of Failures			
	Group 0	Group I	Group II	Group III
3	2%	0.4%	0.2%	0
9 & 11	1%	0.2%	0.1%	0
Combined Total Percent Failures Group 0, I, and II at Test #9 & #11				1%

*If the number of unit failures allowable is calculated to be a mixed number, a combination of an integer and a fraction, use the integer only.

TABLE II

Test Number (See Paragraph 3.3.1)		
Lead bend and fatigue	#2	1 defective
Dimension	#2	1 defective
Leak Test	#5	2 %
Leak Test	#6	2 %
Gain Measurement	#11	1 defective
Internal Vis.	#14	2 defective
External Vis.	#1	4%

4.3 REJECTION CRITERIA

4.3.1 Lot Rejection

The failures of a shipment lot shall be classified as specified in 4.4.2 such that the failures can be identified with the

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PROCESS SPECIFICATION
SPECIAL CONDITIONING OF TRANSISTORS

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11/1	A	23590	1, 2, 4, 8,	WK	A. C. METZGER
(M) 12/21	B	24838	1 & 2	[illegible]	[illegible]

This specification consists of pages 1 to 14 inclusive and cover sheet.

APPROVALS	NASA/MSC		MIT/IL	RAYTHEON	
		Edlund Hall 6/15/65	W Hayden 2[illegible]/65		

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PROCESS SPECIFICATION
SPECIAL CONDITIONING OF TRANSISTORS

1. SCOPE

1.1 PURPOSE

This specification establishes the minimum requirements for the acceptance of transistors SCD 1006310 and SCD 1006323 for use in flyable, deliverable end items. The procedure described herein shall be performed by the G&N Industrial Contractor as part of the incoming inspection, screen and burn-in.

2. APPLICABLE DOCUMENTS

2.1 EFFECTIVE ISSUES

The following documents of the issue in effect on the date of this document form a part of this specification to the extent specified herein.

SPECIFICATIONS

Military

MIL-STD-202C	Test methods for electronic and electrical component parts.
MIL-STD-750	Test methods for semiconductor devices.

DRAWINGS

Apollo G&N

1006310	Transistor, silicon, type PNP, switching.
1006323	Transistor, silicon, type NPN, switching.
2004165	Insulator, Transistor
1006355	Curing agent, low viscosity amine type.
1006356	Epoxy resin, low viscosity.

3. REQUIREMENTS

3.1 GENERAL

The provisions of this specification shall be applicable to all phases of acceptance of transistors to the extent specified herein. Specific requirements or provisions not covered by this specification shall be as specified on the applicable drawing or purchase order. In the event of conflict between the requirements of the applicable drawings, this specification and other documents cited herein, the requirements of the applicable drawings, this specification and the other documents specified herein shall govern in that order.

3.1.1

All transistors which are to remain unpotted and are supplied to this specification must have in-

sulators fabricated from 2004165 affixed to the lead underside of the can utilizing curing agent SCD 1006355 and epoxy resin SCD 1006356.

NOTE: Transistors must have insulators affixed or must be potted prior to test sequence 3.3.1.1.

3.2 PROCESS CONTROL

The process covered by this specification shall be controlled in accordance with the process control provisions of 4.2.

3.2.1 Lot Control

Each lot (6.2.1) as supplied by the vendor in compliance with 1006310 or 1006323 shall be identified and maintained by the contractor throughout the test sequence, 3.3.1.

3.3 TEST PROCEDURES

3.3.1 Test Sequence

Each lot of transistors shall be subjected to tests in the following sequence:

a. External Visual Inspection (Test #1)

b. Physical Dimension, Lead Tension, and Fatigue Inspection (Test #2)

c. Electrical Test (Test #3)

d. Thermal Cycle Test (Test #4)

e. Helium Leak Test (Test #5)

f. Glycerine Bubble Tests (Test #6)

g. High Temperature Bake Test (Test #7)

h. Centrifuge Y_1 Test (Test #8)

i. Electrical Test (Test #9)

j. Emitter-base back bias Test (Test #10)

k. Gain Measurement (Test #11)

m. Operation Life Test (Test #12)

n. Electrical Test (Test #13)

o. Internal Visual Inspection (Test #14)

A flow diagram of the above sequence is attached.

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PROCESS SPECIFICATION
SPECIAL CONDITIONING OF TRANSISTORS

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11/1	A	23590	1, 2, 4, 8,	WK	A. C. METZGER
(M) 12/21	B	24838	1 & 2	EGL	JQF
(M) 12/11/66	C	26203	2,3,4,6,8,9,10,12,14,15,13	Glw FH	AMW FH

This specification consists of pages 1 to 15 inclusive and cover sheet.

APPROVALS	NASA/MSC		MIT/IL	RAYTHEON	
		Edgar Hall 6/15/66	W Taylor 28 Dec 65		

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sulators fabricated from 2004165 affixed to the lead underside of the can utilizing curing agent SCD 1006355 and epoxy resin SCD 1006356.

NOTE: Transistors must have insulators affixed or must be potted at point "S" in test sequence 3.3.1.i.

3.2 PROCESS CONTROL

The process covered by this specification shall be controlled in accordance with the process control provisions of 4.2.

3.2.1 Lot Control

Each lot (6.2.1) as supplied by the vendor in compliance with 1006310 or 1006323 shall be identified and maintained by the contractor throughout the test sequence, 3.3.1.

3.3 TEST PROCEDURES

3.3.1 Test Sequence

Each lot of transistors shall be subjected to tests in the following sequence:

a. External Visual Inspection (Test #1)

b. Physical Dimension, Lead Tension, and Fatigue Inspection (Test #2)

c. Electrical Test (Test #3)

d. Thermal Cycle Test (Test #4)

e. Helium Leak Test (Test #5)

f. Glycerine Bubble Tests (Test #6)

g. High Temperature Bake Test (Test #7)

h. Centrifuge Y_1 Test (Test #8)

i. Electrical Test (Test #9)

j. Emitter-base back bias Test (Test #10)

k. Gain Measurement (Test #11)

m. Operation Life Test (Test #12)

n. Electrical Test (Test #13)

o. Vibration Test (Test #14)

p. Shock Test (Test #15)

3.3.1 Test Sequence (Cont'd)

q. Electrical Test (Test #16)

r. Internal Visual Inspection (Test #17)

s. Insulators or potting

t. Electrical Test (Test #18)

A flow diagram of the above sequence is attached.

3.3.1.1 Removal of Failures

Catastrophic failures only shall be removed from the test sequence at the point of detection and subjected to failure analysis. The point in the test sequence 3.3.1 where the failure was detected must be recorded and a set of electrical readings as specified in Paragraph 3.3.2.3 shall be performed. All electrical failures at the end of the test sequence 3.3.1 shall be subjected to failure analysis except the incoming marginal failures as defined in 6.2.3 (a), which may be returned to the vendor. All non-catastrophic failures shall remain in test until completion of (n) test #13 in test sequence 3.3.1. All failures at (t) test #18 shall be removed from use but not subjected to failure analysis.

3.3.2 Tests

3.3.2.1 External Visual Inspection

Each lot of transistors shall be subjected to an external visual inpsection in accordance with MIL-STD-750, method 2071.

3.3.2.2 Physical Dimension, Lead Tension, & Fatigue

A minimum of 3 samples of transistors shall be subjected to the physical dimension examination of MIL-STD-750, method 2066. The units shall be subjected to the lead tension and lead fatigue tests in accordance with MIL-STD-750 method 2036 conditions A and E and to the requirements of the specification control drawings. The units subjected to the lead tension and lead fatigue tests are to be forwarded to test #17 of the test sequence 3.3.1.

3.3.2.3 Electrical Test (Test #3 of 3.3.1)

a. PNP-SCD 1006310

The entire lot except the devices used in 3.3.2.2 shall be subjected to the following test in the given order:

Collector-emitter saturation voltage Ic = 50 ma
Collector-emitter saturation voltage Ic = 150 ma
DC Current gain at = 1 ma
DC Current gain at = 150 ma
Emitter-base breakdown voltage
Collector-emitter threshold current
Collector-emitter sustaining voltage
Base-emitter saturation voltage

Turn-on, turn-of time is to be performed on a 10% sample basis to the limits and conditions specified in Specification Control Drawing #1006310.

b. NPN-SCD 1006323

The entire lot except the devices in 3.3.2.2 shall be subjected to the following tests in the given order:

Collector-emitter saturation voltage at 150 ma
DC Current Gain at 10 ma
DC Current Gain at 150 ma
Emitter-base breakdown voltage
Collector-emitter threshold current
Collector-emitter breakdown voltage
Collector-emitter sustaining voltage
Base-emitter saturation voltage at 500 ma

Turn-on, turn-off time is to be performed on a 10% sample basis to the limits and conditions specified in Specification Control Drawing 1006323.

3.3.2.4 Electrical Test (Test #9 and #16 of 3.3.1)

a. PNP-SCD 1006310

The entire lot except the devices used in 3.3.2.2 shall be subjected to the following test in the given order:

The tests shall be the same as those outlined in 3.3.2.3 (a) but shall omit the collector-emitter sustaining voltage from the sequence. The limits for the test shall be 4% higher than the maximum and 4% lower than the minimum limits as specified in Specification Control Drawing 1006310.

b. NPN-SCD 1006323

The entire lot except the devices used in 3.3.2.2 shall be subjected to the following tests in the given order:

The tests shall be the same as those outlined in 3.3.2.3 (b) but shall substitute the collector-emitter saturation voltage at 500 ma for the collector-emitter sustaining voltage in the sequence. The limits for the test shall be 4% higher than the maximum and 4% lower than the minimum limits as specified in Specification Control Drawing 1006323.

trol Drawing 1006310.

b. NPN-SCD 1006323

DC Current gain at 10 ma as defined in Specification Control Drawing 1006323.

3.3.2.13 Internal Visual Inspection

The Internal Visual Inspection shall be performed on the 25 units from test #16, para. 3.3.2.15 and 3 samples from test #2, paragraph 3.3.2.2.

3.3.2.14 Vibration Test

The vibration test shall be performed on a random sample of 25 units. The vibration test shall be performed in accordance with MIL-STD-750, Method 2056, 30 g's from 5 to 2000 cps limited to 0.12 inch double amplitude, 3 cycles, 15 minutes per cycle minimum.

3.3.2.15 Shock Test

The shock test shall be performed on the same units tested in 3.3.2.15. The shock test shall be performed in accordance with MIL-STD-750, Method 2016, 1500 g's, 0.5 msec, 5 blows in all axis directions, 30 blows total.

3.3.2.16 Insulators, Encapsulation,

All transistors shall have insulation affixed as per para. 3.3.1 or shall be encapsulated.

3.3.2.17 Electrical test #18

The electrical test shall be the same as 3.3.2.4 except that the 4% higher maximum, 4% lower than minimum shall not apply.

4. QUALITY ASSURANCE PROVISIONS

4.1 GENERAL

In order to assure proper control of the acceptance process covered by this specification, the contractor shall meet all the requirements specified herein and shall provide continuous audit of the acceptance process to assure compliance with the requirements of this specification.

4.1.1 Inspection

The contractor, through his quality assurance or control agency shall be responsible for the performance of all inspection requirements and test specified herein.

4.2 FAILURE CRITERIA

4.2.1 Failure Analysis

All transistors failing in the electrical tests specified in 3.3.2 (Test #3, #9, #11, #13, and #16) except the non-catastrophic failures as defined in 6.2.3 (a), (b), (c), and (e) shall be subjected to a failure analysis sufficient to identify cause and mode of failure. For failure definitions refer to section 6.2.

3. Shorting after first electrical test due to secondary breakdown detected because of a device fault.

4. Catastrophic failures due to surface instabilities.

5. Shorts through the silicon dioxide due to poor oxide dielectric strength.

6. Shorts, intermittent or otherwise, due to particles in the package.

7. Shorts, intermittent or otherwise, due to free lead material or fixed extra leads or lead material.

NOTE: If the leads were designed into the device and the short was not detected at first electrical test, the failure falls into this category.

8. Open bonds detected after first electrical test due to formations of intermetallic compounds of aluminum and gold.

9. Emitter to base shorting detected after first electrical test due to bonds making contact to each other.

10. Open bonds for any cause detected after first electrical test where a substance has been put over the bonds and this substance was the only means of making electrical contact.

GROUP III

1. Any failures, except induced failures, not listed above or any failure for an unknown cause.

TABLE I

Test Number (See Para. 3.3.1)	*Maximum Percentage of Failures			
	Group 0	Group I	Group II	Group III
3	2%	1.0%	0.5%	0
9 & 13	1%	0.5%	0.2%	0
Combined Total Percent Failures Group 0, I, and II at Test #9 & #13				1%

*If the number of unit failures allowable is calculated to be a mixed number, a combination of an integer and a fraction, use the integer only.

TABLE II

Test Number (See Paragraph 3.3.1)		
Lead bend and fatigue	#2	1 defective
Dimension	#2	1 defective
Leak Test	#5	2 %
Leak Test	#6	2 %
Gain Measurement	#11	1 defective
Internal Vis.	#14	2 defective
External Vis.	#1	4 %
Electrical Test	#16	1 defective

4.3 REJECTION CRITERIA

4.3.1 Lot Rejection

The failures of a shipment lot shall be classified as specified in 4.4.2 such that the failures can be identified with the groupings specified in 4.2.3. The maximum allowable percentages of failures from test number 3, 9 and 11 of paragraph 3.3.1 according to the failure mode groupings of 4.2.3 are given in Table I. The maximum allowable percentages of failures from test numbers 2, 5, 6, 11, 16, and 17 of paragraph 3.3.1 are given in Table II where the failure definitions are given in 6.2. Failure to meet any one of the maximum allowable percentages of Tables I and II or failure to comply with the test sequence of 3.3.1 the test procedures 3.3.2, the flight qualification requirements of 4.4 or the data requirements of 4.5 shall be cause for lot rejection.

4.3.1.1 Conformance to MD 1015404

Disclosure of any violation of previously agreed to contractor-supplier MD 1015404 "Critical Process" list without prior notification automatically fails the entire lot. Notice of such deviation must be made by the contractor to MIT/IL within 24 hours of disclosure.

4.4 FLIGHT QUALIFICATION

4.4.1 Flight Qualified Hardware

A transistor is flight qualified when the lot, of which the transistor is part, is not rejected according to 4.3.1 and the transistor does not fail any test of the test sequence of paragraph 3.3.1. Lots that failed the criteria of this specification cannot be resubmitted for flight qualification without waiver. Failures occurring after insulators have been added or potted units shall not affect the flight qualification criteria of the lot.

4.4.1.1 Failure Traceability

Any transistor failure detected in qualified flight hardware must be traceable to a lot as identified in paragraph 3.2.1.

4.4.2 Qualification Report

Two copies of a report justifying the acceptance or rejection of a lot as flight qualified shall be forwarded to MIT/IL, prior to use in deliverable end items. The report shall include the following:

a. A copy of the summary of the supplier's Quality Demonstration test.

b. A summary of screen and burn-in data and a detailed list of the screen and burn-in results which includes the number of failures during test sequence 3.3.1.

c. A failure report of all electrical failures, by unit serial number including induced failures, as specified in 4.2.1 which includes:

c1. Photographs of each category of each photographable failure. A minimum of two photographs for each category is required where more than one exists.

c2. Analysis of each failure.

c3. Classification of each failure according to 4.2.2.

d. A failure report by lot of all internal visual inspection failures (test #17 in test sequence 3.3.1) by unit serial number which includes:

d1. Photographs of each failure category detected.
d2. Classification of each failure according to Section 7.

e. Number of failures in the failure mode groups according to 4.2.3.

f. Date of purchase.

g. Allocation of all parts from the lot updated to the date of issue of qualification report indicating the number of units which passed screen and burn-in, the number of failed units, the number of induced failures and the number of units removed from the lot for any other reason.

h. A list of all process changes allowed by the contractor in accordance with 1015404 paragraph 3.3.2.2.

4.5 DATA

4.5.1 Stored Data

Incoming inspection, screen, and burn-in data shall be maintained and stored by lot number for three years.

c. A non-catastrophic failure at test 3.3.2.4 does not exceed the limits described in 3.3.2.4, but changes parameters from test 3.3.2.3 by more than ± 20%.

d. A non-catastrophic failure at test 3.3.2.4 exceeds the limits described in 3.3.2.4, but changes parameters from test 3.3.2.3 by more than ± 20%.

e. A non-catastrophic failure at test 3.3.2.12 exceeded a change in DC current gain by ±20% in test sequence 3.3.1 test #9 and test #11.

6.2.4 Induced Failures

An induced failure is a catastrophic failure which through failure analysis can be proven to be caused by exceeding the stress limits of Specification Control Drawing 1006310 or 1006323.

6.2.5 Leak Test Failures

A failure at test #5 or #6 of paragraph 3.3.1 is failure to meet the leak test limits as specified in Specification Control Drawing 1006310 or 1006323, and failure criteria of MIL-STD-202C, Method 112, Test Condition A.

6.2.6 External Visual Inspection Failures

A failure at test #1 of paragraph 3.3.1 is a failure to meet the visual and mechanical examination criteria of Specification Control Drawing 1006310 or 1006323.

6.2.7 Physical Dimension Failures

The physical dimension failures of test #2 of paragraph 3.3.1 is a package which does not meet the physical dimension criteria of specification control drawing 1006310 or 1006323.

6.2.8 Lead Tension, Lead Fatigue Failures

The lead tension, lead fatigue failures of test #2 of paragraph 3.3.1 is a partial or complete severing of a lead from the package.

6.2.9 Internal Visual Inspection Failures

A failure at test #17 of paragraph 3.3.1 is failure to meet the criteria of Section 7.

6.2.10 Failures

Failure of a unit in one or more tests will be charged as a single failure. A unit which could be classed by several failure modes shall be classed in the highest numerical modes as listed in 4.2.2. A unit which meets the definition of 6.2.3 (a) or 6.2.3 (b) or (c) shall be counted in Group 0 only.

7. VISUAL REJECTION CRITERIA

The following defines the internal visual rejection criteria for test #17 for silicon planar transistors.

7.1 HIGH POWER INSPECTION

The following inspection shall be performed at 80 power minimum with a columnated light source applied through the objective lens.

7.1.1 "Purple Plaque"

Any device, when viewed from above exhibiting an intermetallic formation of aluminum and gold (purple plaque) is a reject.

7.1.2 Bond Placement

Any device which exhibits bonds whose outer periferies are closer to each other than 0.5 mils is a reject.

7.1.3 Exposed Junction

Any device which exhibits any junction area covered only by unthermally oxidized silicon is a reject.

7.1.4 Cracks in the Die

Any die which exhibits cracks in the active circuit, metalization, or bond areas is a reject. Any die which exhibits cracks 1 mil in length or greater which point toward the active circuit metalization or bonds is a reject.

7.2 LOW POWER INSPECTION

The following inspection shall be performed at 20 power minimum.

7.2.1 Post Height

Any device which exhibits the post height equal to or less than the top of the chip is a reject.

7.2.2 Lead Length

Leads which exhibit sufficient excess length such that there exists the capability of shorting to another lead, edge or surface of the die, or to the bottom or top of the package without deforming the diameter of the lead shall cause the device to be rejected.

7.2.3 Bonds at the Post

Wedge bonds which are made at the post such that the diameter of the wire at regions where the wire does not make metallurgical contact to the post is constricted to less than 1/2 of the normal wire diameter shall cause the device to be a reject.

7.2.4 Damaged Leads

Any lead which exhibits nicks, cuts, crimps, or scoring which cut into or deform the wire by more than 25% of the original diameter shall cause the device to be a reject.

7.2.5 Conducting Particles

Any device which contains loose or easily removable electrically conducting segments of material which are not part of the device design is a reject. Electrically conducting material shall include any material of sufficient conductance to cause device failure of any electrical specification by shorting contacts.

7.2.6 Surface Coating

Any device which exhibits a surface coating is a reject.

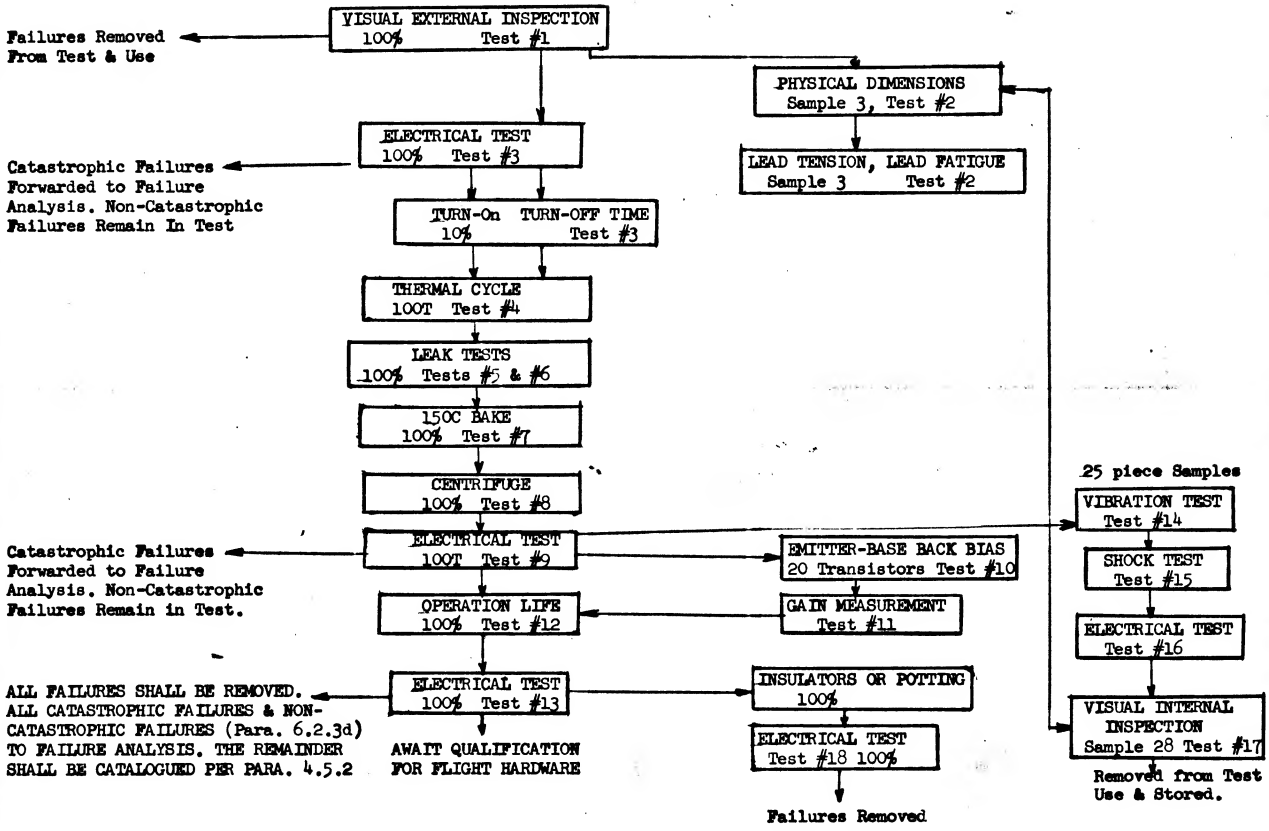
7.2.7 Double Leads

Any device which has more than one bond making electrical contact to any one terminal of the transistor is a reject.

7.2.8 Lead Material

Any device which exhibits lead material greater in length than 2 wire diameters that is fixed only on one end, is a reject.

FLOW DIAGRAM FOR THE TEST SEQUENCE 3.3.1



Apollo G&N Specification
ND 1002266 Rev. D
Original Issue Date: 6/14/65
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Class A Release

PROCESS SPECIFICATION
SPECIAL CONDITIONING OF TRANSISTORS

DATE	REVISION LETTER	TDRR NO.	PAGES REVISED	APPROVALS	
				MIT	NASA
11/1	A	23590	1, 2, 4, 8,	WF	A. C. METZGER
12/21	B	24838	1 & 2	EWL	JAF
2/11/66	C	26203	2,3,4,6,8,9,10,12,14,15,13	Chas FM	Chas FM
1/5/67	D	32564	1,2,3,4,5,6,7,8,9,11,12,	Chas F.G	Chas F.G
			13,14,15		

This specification consists of pages 1 to 15 inclusive and cover sheet.

APPROVALS	NASA/MSC		MIT/IL	RAYTHEON
		Edmund Hall 6/15/66	W F Hyslop 2/8/67	

NOT REQUIRED PER LETTER
NASA PP7-65-612

PROCESS SPECIFICATION
SPECIAL CONDITIONING OF TRANSISTORS

1. SCOPE

1.1 PURPOSE

This specification establishes the minimum requirements for the acceptance of transistors SCD 1006310 and SCD 1006323 for use in flyable, deliverable end items. The procedure described herein shall be performed by the G&N Industrial Contractor as part of the incoming inspection, screen and burn-in.

2. APPLICABLE DOCUMENTS

2.1 EFFECTIVE ISSUES

The following documents of the issue in effect on the date of this document form a part of this specification to the extent specified herein.

SPECIFICATIONS

Military

MIL-STD-202C	Test methods for electronic and electrical component parts.
MIL-STD-750	Test methods for semiconductor devices.
MIL-STD-105D	Sampling procedures and tables for inspection by attributes.

DRAWINGS

Apollo G&N

1006310	Transistor, silicon, type PNP, switching
1006323	Transistor, silicon, type NPN, switching
2004004	Transistor, silicon (flight qualified)

3. REQUIREMENTS

3.1 GENERAL

The provisions of this specification shall be applicable to all phases of acceptance of transistors to the extent specified herein. Specific requirements or provisions not covered by this specification shall be as specified on the applicable drawing or purchase order. In the event of conflict between the requirements of the applicable drawings, this specification and other documents cited herein, the requirements of the applicable drawings, this specification and the other documents specified herein shall govern in that order.

3.1.1 All transistors shall be encapsulated per 2004004.

NOTE: Transistors must be encapsulated at point "S" in test sequence 3.3.1.

3.2 PROCESS CONTROL

The process covered by this specification shall be controlled in accordance with the process control provisions of 4.0.

3.2.1 Lot Control

Each lot (6.2.1) as supplied by the vendor in compliance with 1006310 or 1006323 shall be identified and maintained by the contractor throughout the test sequence, 3.3.1.

3.3 TEST PROCEDURES

3.3.1 Test Sequence

The test sequence shall be in accordance with the attached flow diagram (Figure I).

a. External Visual Inspection (Test #1)
b. Physical Dimension, Lead Tension, and Fatigue Inspection (Test #2)
c. Electrical Test (Test #3)
d. Thermal Cycle Test (Test #4)
e. Helium Leak Test (Test #5)
f. Glycerine Bubble Tests (Test #6)
g. High Temperature Bake Test (Test #7)
h. Centrifuge Y_1 Test (Test #8)
i. Electrical Test (Test #9)
j. Emitter-base back bias Test (Test #10)
k. Gain Measurement (Test #11)
m. Operation Life Test (Test #12)
n. Electrical Test (Test #13)
o. Vibration Test (Test #14)
p. Shock Test (Test #15)

3.3.1 Test Sequence (Cont'd)

q. Electrical Test (Test #16)

r. Internal Visual Inspection (Test #17)

s. Encapsulation

t. Electrical Test (Test #18)

A flow diagram of the above sequence is attached.

3.3.1.1 Removal of Failures

Catastrophic failures only shall be removed from the test sequence at the point of detection and subjected to failure analysis. The point in the test sequence 3.3.1 where the failure was detected must be recorded and a set of electrical readings as specified in Paragraph 3.3.2.3 shall be performed. All electrical failures at the end of the test sequence 3.3.1 shall be subjected to failure analysis except the incoming marginal failures as defined in 6.2.3 (a), M may be returned to the vendor. All non-catastrophic failures shall remain in test until completion of (n) test #13 in test sequence 3.3.1. All failures at (t) test #18 shall be removed from use but not subjected to failure analysis.

3.3.2 Tests

3.3.2.1 External Visual Inspection

Each lot of transistors shall be subjected to an external visual inpsection in accordance with MIL-STD-750, method 2071.

3.3.2.2 Physical Dimension, Lead Tension, & Fatigue

A minimum of 3 samples of transistors shall be subjected to the physical dimension examination of MIL-STD-750, method 2066. The units shall be subjected to the lead tension and lead fatigue tests in accordance with MIL-STD-750 method 2036 conditions A and E and to the requirements of the specification control drawings. The units subjected to the lead tension and lead fatigue tests are to be forwarded to test #17 of the test sequence 3.3.1.

3.3.2.3 Electrical Test (Test #3 of 3.3.1)

a. PNP-SCD 1006310

The entire lot except the devices used in 3.3.2.2 shall be subjected to the following test in the given order:

Collector-emitter saturation voltage Ic = 50 ma
Collector-emitter saturation voltage Ic = 150 ma
DC Current gain at = 1 ma
DC Current gain at = 150 ma
Emitter-base breakdown voltage
Collector-emitter threshold current
Collector-emitter sustaining voltage
Base-emitter saturation voltage

THIS IS A REPRODUCIBLE COPY OF A DRAWING
DO NOT ALTER OR CHANGE IN ANY WAY

Turn-on, Turn-off time is to be performed on a 10% sample basis to the limits and conditions specified in Specification Control Drawing #1006310.

b. NPN-SCD 1006323

The entire lot except the devices in 3.3.2.2 shall be subjected to the following tests in the given order:

Collector-emitter saturation voltage at 150 ma
DC Current Gain at 10 ma
DC Current Gain at 150 ma
Emitter-base breakdown voltage
Collector-emitter threshold current
Collector-emitter breakdown voltage
Collector-emitter sustaining voltage
Base-emitter saturation voltage at 500 ma

Turn-on, turn-off time is to be performed on a sample basis to a .65% AQL to the limits and conditions specified in Specification Control Drawing 1006323.

3.3.2.4 Electrical Test (Test #9, #13, #16 and #18)

a. PNP-SCD 1006310

The entire lot except the devices used in 3.3.2.2 shall be subjected to the following test in the given order:

The tests shall be the same as those outlined in 3.3.2.3 (a) but shall omit the collector-emitter sustaining voltage from the sequence. The limits for the test shall be 4% higher than the maximum and 4% lower than the minimum limits as specified in Specification Control Drawing 1006310.

b. NPN-SCD 1006323

The entire lot except the devices used in 3.3.2.2 shall be subjected to the following tests in the given order:

The tests shall be the same as those outlined in 3.3.2.3 (b) but shall substitute the collector-emitter saturation voltage at 500 ma for the collector-emitter sustaining voltage in the sequence. The limits for the test shall be 4% higher than the maximum and 4% lower than the minimum limits as specified in Specification Control Drawing 1006323.

3.3.2.5 Thermal Cycle Test

The units shall be subjected to three (3) thermal cycles under the following conditions:

Step	Temperature °C	Time
1	150 ± 5	30 minutes
2	25 ± 5	*NMT 10 seconds
3	-65 ± 5	30 minutes
4	25 ± 5	*NMT 10 seconds

3.3.2.6 Helium Leak Test

The helium leak test shall be performed to the limits of Specification Control Drawing 1006310 or 1006323 in accordance with MIL-STD-202C, method 112, test condition C.

3.3.2.7 Glycerine Bubble Test

The oil bubble test shall be performed in accordance with MIL-202C method 112, test condition A, except the glycerine shall be used.

3.3.2.8 High Temperature Bake Test

The high temperature bake test shall be performed in accordance with MIL-STD-750, method 1031, except the temperature shall be 150 ± 5°C and the time shall be 168 ± 8 hours.

3.3.2.9 Centrifuge Y_1 Test

The centrifuge test shall be performed with an acceleration of 20,000g along the Y_1 axis in accordance with MIL-STD-750, method 2006.

3.3.2.10 Operation Life Test

The Operation Life Test shall be performed in accordance with MIL-STD-750, method 1036 except that the operational time shall be 240 ± 8 hours. The transistors shall be operated at a power of 350 milliwatts and a test period shall consist of 4 minutes "on" and 1 minute "off".

3.3.2.11 Emitter-Base Back Bias Test

The emitter-base back bias test shall be performed on 20 units. Each base input shall be connected to: PNP-SCD-1006310-plus 9 volts, NPN-SCD-1006323 minus 6 volts with respect to the emitter via a 10K resistor in series with each base. The units shall be operated with voltage applied at a temperature of 25° ± 5°C for a period of 72 ± 8 hrs.

3.3.2.12 Gain Measurement (Test #11)

a. PNP-SCD 1006310

DC current gain at 1 ma as defined in Specification Con-

*Transfer time not more than (NMT) 10 seconds.

trol Drawing 1006310.

b. NPN-SCD 1006323

DC Current gain at 10 ma as defined in Specification Control Drawing 1006323.

3.3.2.13 Internal Visual Inspection

The Internal Visual Inspection shall be performed on the 25 units from test #16, para. 3.3.2.15 and 3 samples from test #2, paragraph 3.3.2.2.

3.3.2.14 Vibration Test

The vibration test shall be performed on a random sample of 25 units. The vibration test shall be performed in accordance with MIL-STD-750, Method 2056, 30 g's from 5 to 2000 cps limited to 0.12 inch double amplitude, 3 cycles, 15 minutes per cycle minimum.

3.3.2.15 Shock Test

The shock test shall be performed on the same units tested in 3.3.2.14. The shock test shall be performed in accordance with MIL-STD-750, Method 2016, 1500 g's, 0.5 msec, 5 blows in all axis directions, 30 blows total.

3.3.2.16 Insulators, Encapsulation

All transistors shall be encapsulated per para. 3.1.1.

4. QUALITY ASSURANCE PROVISIONS

4.1 GENERAL

In order to assure proper control of the acceptance process covered by this specification, the contractor shall meet all the requirements specified herein and shall provide continuous audit of the acceptance process to assure compliance with the requirements of this specification.

4.1.1 Inspection

The contractor, through his quality assurance or control agency shall be responsible for the performance of all inspection requirements and test specified herein.

4.2 FAILURE CRITERIA

4.2.1 Failure Analysis

All transistors failing in the electrical tests specified in 3.3.2 (Test #3, #9, #11, #13, and #16) except the non-catastrophic failures as defined in 6.2.3 (a) and (c) shall be subjected to a failure analysis sufficient to identify cause and mode of failure. For failure definitions refer to section 6.2.

4.2.2 Failure Mode Groupings

After failure analysis, all failures detected at tests #3, #9, #11 and #13 of test sequence 3.3.1, except induced failures, shall be grouped as described below and the percentage failure for the lot in each group shall be determined.

Group 0 - Test #3

Non-catastrophic failures as defined in 6.2.3 (a) and switching time failures.

Group I

1. Open bonds due to poor metal adhesion to silicon or silicon dioxide.
2. Open bonds due to underbonding (insufficient pressure and/or temperature).
3. Open bonds due to overbonding (excessive pressure and/or temperature) exclusive of thinning of lead wires of ultrasonic or wedge bonding.
4. Opens in lead wires due to nicks, cuts or crimps in lead wires.
5. Opens due to chip becoming detached from the header.
6. Collector to emitter shorting and/or opening of leads due to the V_{CEO} (sust) test or secondary breakdown at first electrical test.
7. Failures due to cracked chip.
8. Non-catastrophic failures due to surface instabilities.
9. Emitter to base shorts detected at first electrical test due to bonds making contact to each other.
10. Shorts, intermittent or otherwise, detected at first electrical test due to free lead material or fixed extra leads designed into the device.
11. Open bonds detected at first electrical test due to formation of intermetallic compounds of aluminum and gold.

Group II

1. Leads shorting to the surface or edge of the chip, to the can or header, or to each other due to excessive lead length.
2. Leads shorting to the chip because of insufficient post height.

3. Shorting after first electrical test due to secondary breakdown detected because of a device fault.

4. Catastrophic failures due to surface instabilities.

5. Shorts through the silicon dioxide due to poor oxide dielectric strength.

6. Shorts, intermittent or otherwise, due to particles in the package.

7. Shorts, intermittent or otherwise, due to free lead material or fixed extra leads or lead material.

NOTE: If the leads were designed into the device and the short was not detected at first electrical test, the failure falls into this category.

8. Open bonds detected after first electrical test due to formations of intermetallic compounds of aluminum and gold.

9. Emitter to base shorting detected after first electrical test due to bonds making contact to each other.

10. Open bonds for any cause detected after first electrical test where a substance has been put over the bonds and this substance was the only means of making electrical contact.

11. Opens due to excessive thinning of lead wires at the base of the bond.

Group III

1. Any failures, except induced failures, not listed above or any failure for an unknown cause.

TABLE I

Test Number (See Para. 3.3.1)	*Maximum Percentage of Failures			
	Group 0	Group I	Group II	Group III
3	2%	1.0%	0.5%	0
9 & 13		0.5%	0.2%	0

*If the number of unit failures allowable is calculated to be a mixed number, a combination of an integer and a fraction, use the integer only.

TABLE II

Test Number (See Paragraph 3.3.1)		
Lead bend and fatigue	#2	1 defective
Dimension	#2	1 defective
Leak Test	#5	2 %
Leak Test	#6	2 %
Gain Measurement	#11	1 defective
Internal Vis.	#17	2 defective
Electrical Test	#16	1 defective
[illegible] Test	1	1 defective

4.3 REJECTION CRITERIA

4.3.1 Lot Rejection

The failures of a shipment lot shall be classified as specified in 4.4.2 such that the failures can be identified with the groupings specified in 4.2.3. The maximum allowable percentages of failures from test number 3, 9 and 11 of paragraph 3.3.1 according to the failure mode groupings of 4.2.3 are given in Table I. The maximum allowable percentages of failures from test numbers 2, 5, 6, 11, 16, and 17 of paragraph 3.3.1 are given in Table II where the failure definitions are given in 6.2. Failure to meet any one of the maximum allowable percentages of Tables I and II or failure to comply with the test sequence of 3.3.1 the test procedures 3.3.2, the flight qualification requirements of 4.4 or the data requirements of 4.5 shall be cause for lot rejection.

4.3.1.1 Conformance to ND 1015404

Disclosure of any violation of previously agreed to contractor-supplier ND 1015404 "Critical Process" list without prior notification automatically fails the entire lot. Notice of such deviation must be made by the contractor to MIT/IL within 24 hours of disclosure.

4.4 FLIGHT QUALIFICATION

4.4.1 Flight Qualified Hardware

A transistor is flight qualified when the lot, of which the transistor is part, is not rejected according to 4.3.1 and the transistor does not fail any test of the test sequence of paragraph 3.3.1. Lots that failed the criteria of this specification cannot be resubmitted for flight qualification without waiver. Failures occurring after encapsulation shall not affect the flight qualification criteria of the lot. [illegible]

4.5.2 Cataloging

Transistors failing the tests specified herein with the exception of the external visual inspection and leak tests shall be cataloged and stored by lot number for three years. The devices must be readily accessible for future reference.

4.5.3 Lot Storage

Units submitted to the contractor as part of the Quality Demonstration Test shall be stored by contractor's lot number for three years. The devices must be readily accessible for future reference.

5. PREPARATION FOR DELIVERY

This section is not applicable to this specification.

6. NOTES

6.1 INTENDED USE

This process conditions transistors used in Apollo Flight Guidance and Navigation Equipment.

6.2 DEFINITIONS

6.2.1 Lot

A lot is defined as a group of transistors submitted each by a vendor in compliance with 1006310 or 1006323. All serialized units of each lot must be identifiable to that lot.

6.2.2 Catastrophic Failures

A catastrophic failure is defined as any device which fails the electrical tests by twice the maximum or one half the minimum limits as specified in Table II of SCD's 1006310 and 1006323.

6.2.3 Non-Catastrophic Failures

Non-catastrophic failure is any device which cannot be classed as a catastrophic failure by definition 6.2.2 but which fails according to the definitions described below:

a. A non-catastrophic failure at test 3.3.2.3 exceed the limits of Table II of Specification Control Drawing 1006310 or 1006323 and does not become a catastrophic failure during test sequence 3.3.1.

b. A non-catastrophic failure at test 3.3.2.4 exceeds the limits described in 3.3.2.4: but does not become a catastrophic failure (6.2.2).

c. A non-catastrophic failure at test 3.3.2.12 exceeded a change in D.C. current gain by ± 20% in test sequence 3.3.1 test #9 and test #11.

6.2.4 Induced Failures

An induced failure is a catastrophic failure which through failure analysis can be proven to be caused by exceeding the stress limits of Specification Control Drawing 1006310 or 1006323.

6.2.5 Leak Test Failures

A failure at test #5 or #6 of paragraph 3.3.1 is failure to meet the leak test limits as specified in Specification Control Drawing 1006310 or 1006323, and failure criteria of MIL-STD-202C, Method 112, Test Condition A.

6.2.6 External Visual Inspection Failures

A failure at test #1 of paragraph 3.3.1 is a failure to meet the visual and mechanical examination criteria of Specification Control Drawing 1006310 or 1006323.

6.2.7 Physical Dimension Failures

The physical dimension failures of test #2 of paragraph 3.3.1 is a package which does not meet the physical dimension criteria of specification control drawing 1006310 or 1006323.

6.2.8 Lead Tension, Lead Fatigue Failures

The lead tension, lead fatigue failures of test #2 of paragraph 3.3.1 is a partial or complete severing of a lead from the package.

6.2.9 Internal Visual Inspection Failures

A failure at test #17 of paragraph 3.3.1 is failure to meet the criteria of Section 7.

6.2.10 Failures

Failure of a unit in one or more tests will be charged as a single failure. A unit which could be classed by several failure modes shall be classed in the highest numerical modes as listed in 4.2.2. A unit which meets the definition of 6.2.3 (a) shall be counted in Group 0 only.

7. VISUAL REJECTION CRITERIA

The following defines the internal visual rejection criteria for test #17 for silicon planar transistors.

7.1 HIGH POWER INSPECTION

The following inspection shall be performed at 80 power minimum with a columnated light source applied through the objective lens.

7.1.1 GOLD ALUMINUM INTERMETALLIC COMPOUND

Any device when viewed from above exhibiting any intermetallic formation of aluminum and gold shall be subjected to the vertical lead pull test. Any device containing a bond which exhibits a bond failure at less than three gram pull shall be a reject.

7.1.2 BOND PLACEMENT

Any device which exhibits bonds whose outer periferies are closer to each other than 0.5 mils is a reject Any bond which when viewed directly from above, overlaps, or appears to make contact to:

a. The emitter metalization when the lead forms the base bond.

b. The base metalization when the lead forms the emitter bond; is a reject.

7.1.3 Exposed Junction

Any device which exhibits any junction area covered only by unthermally oxidized silicon is a reject.

7.1.4 Cracks in the Die

Any die which exhibits cracks in the active circuit, metalization, or bond areas is a reject. Any die which exhibits cracks 1 mil in length or greater which point toward the active circuit metalization or bonds is a reject.

7.2 LOW POWER INSPECTION

The following inspection shall be performed at 20 power minimum.

7.2.1 Post Height

Any device which exhibits the post height equal to or less than the top of the chip is a reject.

7.2.2 Lead Length

Leads which exhibit sufficient excess length such that there exists the capability of shorting to another lead, edge or surface of the die, or to the bottom or top of the package without deforming the diameter of the lead shall cause the device to be rejected.

7.2.3 Bonds at the Post

Wedge bonds which are made at the post such that the diameter of the wire at regions where the wire does not make metallurgical contact to the post is constricted to less than 1/2 of the normal wire diameter shall cause the device to be a reject.

7.2.4 Damaged Leads

Any lead which exhibits nicks, cuts, crimps, or scoring which cut into or deform the wire by more than 25% of the original diameter shall cause the device to be a reject.

7.2.5 Conducting Particles

Any device which contains loose or easily removable electrically conducting segments of material which are not part of the device design is a reject. Electrically conducting material shall include any material of sufficient conductance to cause device failure of any electrical specification by shorting contacts.

7.2.6 Surface Coating

Any device which exhibits a surface coating is a reject.

7.2.7 Double Leads

a. Any device which has more than one bond making electrical contact to any one terminal of the transistor chip is a reject.

b. Any device which exhibits lead material greater in length than 2 wire diameters that is fixed only on one end, is a reject.

FLOW DIAGRAM FOR THE TEST SEQUENCE 3.3.1

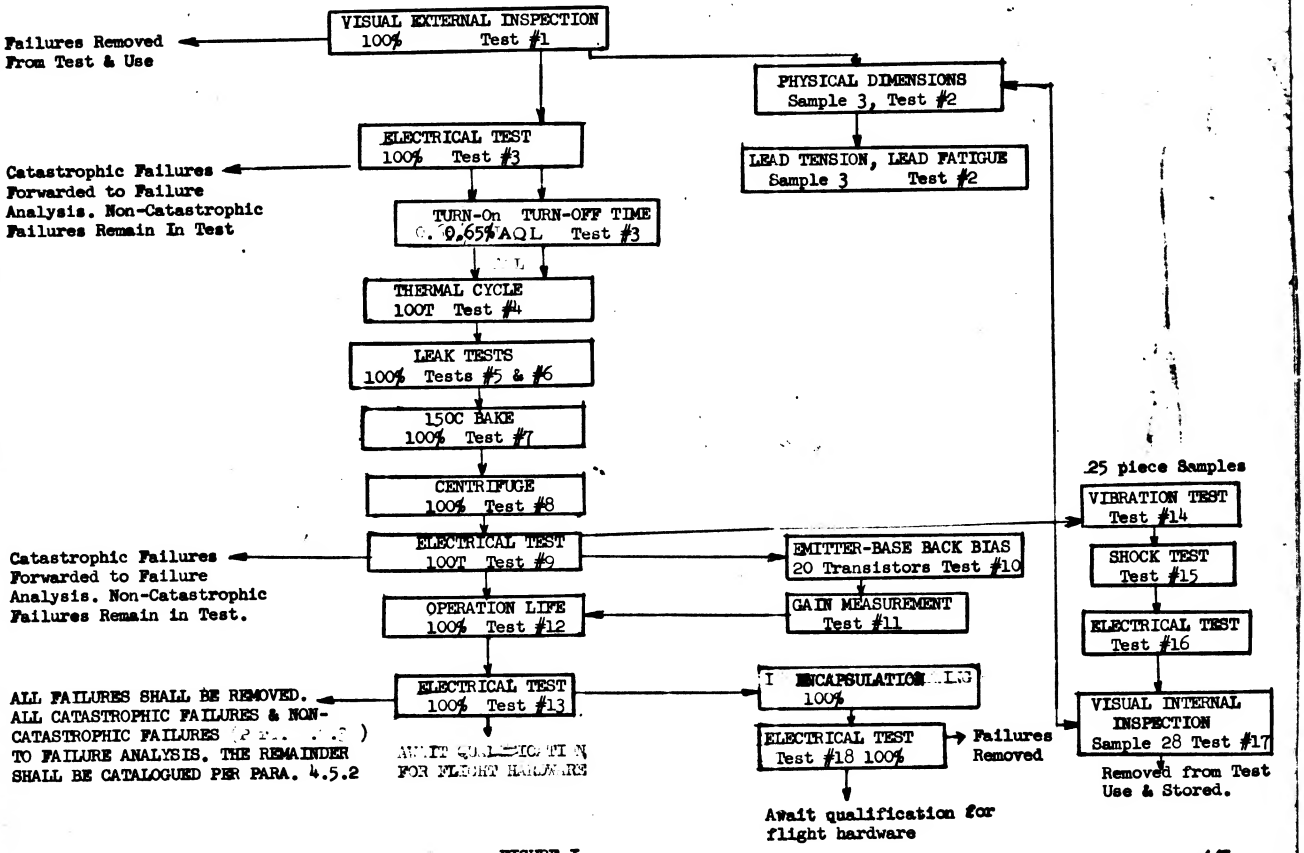


FIGURE I

Apollo G&N Specification
ND 1002266
Original Issue Date: 6/14/65
Release Authority: TDRR 22814
Class A Release

PROCESS SPECIFICATION
SPECIAL CONDITIONING OF TRANSISTORS

DATE	REVISION LETTER	TDRR NO.	PAGES REVISED	APPROVALS	
				MIT	NASA

This specification consists of pages 1 to 14 inclusive and cover sheet.

APPROVALS	NASA/MSC		MIT/IL	RAYTHEON
		Edmund Hall 6/15/65	W Kaysler 6/24/65	

NOT REQUIRED PER LETTER
NASA PP7-65-612

PROCESS SPECIFICATION
SPECIAL CONDITIONING OF TRANSISTORS

1. SCOPE

1.1 PURPOSE

This specification establishes the minimum requirements for the acceptance of transistors SCD 1006310 and SCD 1006323 for use in flyable, deliverable end items. The procedure described herein shall be performed by the G&N Industrial Contractor as part of the incoming inspection, screen and burn-in.

2. APPLICABLE DOCUMENTS

2.1 EFFECTIVE ISSUES

The following documents of the issue in effect on the date of this document form a part of this specification to the extent specified herein.

SPECIFICATIONS

Military

MIL-STD-202C	Test methods for electronic and electrical component parts.
MIL-STD-750	Test methods for semiconductor devices.

DRAWINGS

Apollo G&N

1006310	Transistor, silicon, type PNP, switching.
1006323	Transistor, silicon, type NPN, switching.
1006352	Insulation sheet, electrical silicon impregnated asbestos.
1006355	Curing agent, low viscosity amine type.
1006356	Epoxy resin, low viscosity.

3. REQUIREMENTS

3.1 GENERAL

The provisions of this specification shall be applicable to all phases of acceptance of transistors to the extent specified herein. Specific requirements or provisions not covered by this specification shall be as specified on the applicable drawing or purchase order. In the event of conflict between the requirements of the applicable drawings, this specification and other documents cited herein, the requirements of the applicable drawings, this specification and the other documents specified herein shall govern in that order.

3.1.1

All transistors supplied to this specification must have in-

sulators fabricated from SCD 1006352 affixed to the lead underside of the can utilizing curing agent SCD 1006355 and epoxy resin SCD 1006356.

NOTE: Transistors must have insulators affixed prior to test sequence 3.3.1.

3.2 PROCESS CONTROL

The process covered by this specification shall be controlled in accordance with the process control provisions of 4.2.

3.2.1 Lot Control

Each lot (6.2.1) as supplied by the vendor in compliance with 1006310 or 1006323 shall be identified and maintained by the contractor throughout the test sequence, 3.3.1.

3.3 TEST PROCEDURES

3.3.1 Test Sequence

Each lot of transistors shall be subjected to tests in the following sequence:

a. External Visual Inspection (Test #1)

b. Physical Dimension, Lead Tension, and Fatigue Inspection (Test #2)

c. Electrical Test (Test #3)

d. Thermal Cycle Test (Test #4)

e. Helium Leak Test (Test #5)

f. Glycerine Bubble Tests (Test #6)

g. High Temperature Bake Test (Test #7)

h. Centrifuge Y_1 Test (Test #8)

i. Electrical Test (Test #9)

j. Emitter-base back bias Test (Test #10)

k. Gain Measurement (Test #11)

m. Operation Life Test (Test #12)

n. Electrical Test (Test #13)

o. Internal Visual Inspection (Test #14)

A flow diagram of the above sequence is attached.

3.3.1.1 Removal of Failures

Catastrophic failures only shall be removed from the test sequence at the point of detection and subjected to failure analysis. The point in the test sequence 3.3.1 where the failure was detected must be recorded and a set of electrical readings as specified in Paragraph 3.3.2.3 shall be performed. All electrical failures at the end of the test sequence 3.3.1 shall be subjected to failure analysis except the incoming marginal failures as defined in 6.2.3 (a), may be returned to the vendor.

3.3.2 Tests

3.3.2.1 External Visual Inspection

Each lot of transistors shall be subjected to an external visual inspection in accordance with MIL-STD-750, method 2071. Transistors shall be visually inspected for presence of insulators as referenced in paragraph 3.1.1.

3.3.2.2 Physical Dimension, Lead Tension, & Fatigue

A minimum of 3 samples of transistors shall be subjected to the physical dimension examination of MIL-STD-750, method 2066. The units shall be subjected to the lead tension and lead fatigue tests in accordance with MIL-STD-750 method 2036 conditions A and E and to the requirements of the specification control drawings. The units subjected to the lead tension and lead fatigue tests are to be forwarded to test #14 of the test sequence 3.3.1.

3.3.2.3 Electrical Test (Test #3 of 3.3.1)

a. PNP-SCD 1006310

The entire lot except the devices used in 3.3.2.2 shall be subjected to the following test in the given order:

Collector-emitter saturation voltage Ic - 50 ma
Collector-emitter saturation voltage Ic -150 ma
DC Current gain at - 1 ma
DC Current gain at -150 ma
Emitter-base breakdown voltage
Collector-emitter threshold current
Collector-emitter sustaining voltage
Base-emitter saturation voltage

Turn-on, turn-of time is to be performed on a 10% sample basis to the limits and conditions specified in Specification Control Drawing #1006310.

b. NPN-SCD 1006323

The entire lot except the devices in 3.3.2.2 shall be subjected to the following tests in the given order:

Collector-emitter saturation voltage at 150 ma
DC Current Gain at 10 ma
DC Current Gain at 150 ma
Emitter-base breakdown voltage
Collector-emitter threshold current
Collector-emitter breakdown voltage
Base-emitter saturation voltage at 500 ma

Turn-on, turn-off time is to be performed on a 10% sample basis to the limits and conditions specified in Specification Control Drawing 1006323.

3.3.2.4 Electrical Test (Test #9 and #13 of 3.3.1)

a. PNP-SCD 1006310

The entire lot except the devices used in 3.3.2.2 shall be subjected to the following test in the given order:

The tests shall be the same as those outlined in 3.3.2.3 (a) but shall omit the collector-emitter sustaining voltage from the sequence. The limits for the test shall be 4% higher than the maximum and 4% lower than the minimum limits as specified in Specification Control Drawing 1006310.

b. NPN-SCD 1006323

The entire lot except the devices used in 3.3.2.2 shall be subjected to the following tests in the given order:

The tests shall be the same as those outlined in 3.3.2.3 (b) but shall substitute the collector-emitter saturation voltage at 500 ma for the collector-emitter sustaining voltage in the sequence. The limits for the test shall be 4% higher than the maximum and 4% lower than the minimum limits as specified in Specification Control Drawing 1006323..

3.3.2.5 Thermal Cycle Test

The units shall be subjected to three (3) thermal cycles under the following conditions.

Step	Temperature °C	Time
1	150 ± 5	30 minutes
2	25 ± 5	*NMT 10 seconds
3	-65 ± 5	30 minutes
4	25 ± 5	*NMT 10 seconds

3.3.2.6 Helium Leak Test

The helium leak test shall be performed to the limits of Specification Control Drawing 1006310 or 1006323 in accordance with MIL-STD-202C, method 112, test condition C.

3.3.2.7 Glycerine Bubble Test

The oil bubble test shall be performed in accordance with MIL-202C method 112, test condition A, except the glycerine shall be used.

3.3.2.8 High Temperature Bake Test

The high temperature bake test shall be performed in accordance with MIL-STD-750, method 1031, except the temperature shall be 150 ± 5°C and the time shall be 168 ± 8 hours.

3.3.2.9 Centrifuge Y_1 Test

The centrifuge test shall be performed with an acceleration of 20,000g along the Y_1 axis in accordance with MIL-STD-750, method 2006.

3.3.2.10 Operation Life Test

The operation life test shall be performed in accordance with MIL-STD-750, method 1026, and Specification Control Drawing 1006310 or 1006323 except that the time shall be 240 ± 8 hours.

3.3.2.11 Emitter-Base Back Bias Test

The emitter-base back bias test shall be performed on 20 units. Each base input shall be connected to: PNP-SCD-1006310 - plus 6 volts, NPN-SCD-1006323 minus 6 volts with respect to the emitter via a 10K resistor in series with each base. The units shall be operated with voltage applied at a temperature of 25°±5°C for a period of 72 ± 8 hrs.

3.3.2.12 Gain Measurement (Test #11)

a. PNP-SCD 1006310

DC current gain at 1 ma as defined in Specification Con-

*Transfer time not more than (NMT) 10 seconds.

trol Drawing 1006310.

b. NPN-SCD 1006323

DC Current gain at 10 ma as defined in Specification Control Drawing 1006323.

3.3.2.13 Internal Visual Inspection

The Internal Visual Inspection shall be performed on the 17 units from Quality Demonstration Test subgroup 3 and 3 samples from test #2, paragraph 3.3.2.2.

4. QUALITY ASSURANCE PROVISIONS

4.1 GENERAL

In order to assure proper control of the acceptance process covered by this specification, the contractor shall meet all the requirements specified herein and shall provide continuous audit of the acceptance process to assure compliance with the requirements of this specification.

4.1.1 Inspection

The contractor, through his quality assurance or control agency shall be responsible for the performance of all inspection requirements and test specified herein.

4.2. FAILURE CRITERIA

4.2.1 Failure Analysis

All transistors failing in the electrical tests specified in 3.3.2 (Test #3, #9, #11 and #13) except the non-catastrophic failures as defined in 6.2.3 (a), (b), (c), and (e) shall be subjected to a failure analysis sufficient to identify cause and mode of failure. For failure definitions refer to section 6.2.

4.2.2 Failure Mode Groupings

After failure analysis, all failures detected at tests #3, #9, #11, and #13 of test sequence 3.3.1, except induced failures, shall be grouped as described below and the percentage failure for the lot in each group shall be determined.

Group 0 - Test #3

Non-catastrophic failures as defined in 6.2.3 (a) and switching time failures.

Group 0 - Test #9 and #11

Non-catastrophic failures as defined in 6.2.3 (b) and (c).

Group I

1. Open bonds due to poor metal adhesion to silicon or silicon dioxide.

2. Open bonds due to underbonding (insufficient pressure and/or temperature).

3. Open bonds due to overbonding (excessive pressure and/or temperature).

4. Opens in lead wires due to nicks, cuts or crimps in lead wires.

5. Opens due to excessive thinning of lead wires at the base of the bond.

6. Opens due to chip becoming detached from the header.

7. Collector to emitter shorting and/or opening of leads due to the V_{CEO} (sust) test or secondary breakdown at first electrical test.

8. Failures due to cracked chip.

9. Non-catastrophic failures due to surface instabilities.

10. Emitter to base shorts detected at first electrical test due to bonds making contact to each other.

11. Shorts, intermittent or otherwise, detected at first electrical test due to free lead material or fixed extra leads designed into the device.

12. Open bonds detected at first electrical test due to formation of intermetallic compounds of aluminum and gold.

GROUP II

1. Leads shorting to the surface or edge of the chip, to the can or header, or to each other due to excessive lead length.

2. Leads shorting to the chip because of insufficient post height.

3. Shorting after first electrical test due to secondary breakdown detected because of a device fault.

4. Catastrophic failures due to surface instabilities.

5. Shorts through the silicon dioxide due to poor oxide dielectric strength.

6. Shorts, intermittent or otherwise, due to particles in the package.

7. Shorts, intermittent or otherwise, due to free lead material or fixed extra leads or lead material.

NOTE: If the leads were designed into the device and the short was not detected at first electrical test, the failure falls into this category.

8. Open bonds detected after first electrical test due to formations of intermetallic compounds of aluminum and gold.

9. Emitter to base shorting detected after first electrical test due to bonds making contact to each other.

10. Open bonds for any cause detected after first electrical test where a substance has been put over the bonds and this substance was the only means of making electrical contact.

GROUP III

1. Any failures, except induced failures, not listed above or any failure for an unknown cause.

TABLE I

Test Number (See Para.3.3.1)	*Maximum Percentage of Failures			
	Group 0	Group I	Group II	Group III
3	2%	0.4%	0.2%	0
9 & 11	1%	0.2%	0.1%	0
Combined Total Percent Failures Group 0, I, and II at Test #9 & #11				1%

*If the number of unit failures allowable is calculated to be a mixed number, a combination of an integer and a fraction, use the integer only.

TABLE II

Test Number (See Paragraph 3.3.1)		
Lead bend and fatigue	#2	1 defective
Dimension	#2	1 defective
Leak Test	#5	2 %
Leak Test	#6	2 %
Gain Measurement	#11	1 defective
Internal Vis.	#14	2 defective

4.3 REJECTION CRITERIA

4.3.1 Lot Rejection

The failures of a shipment lot shall be classified as specified in 4.4.2 such that the failures can be identified with the

groupings specified in 4.2.3. The maximum allowable percentages of failures from test number 3, 9 and 11 of paragraph 3.3.1 according to the failure mode groupings of 4.2.3 are given in Table I. The maximum allowable percentages of failures from test numbers 2, 5, 6, 11 and 14 of paragraph 3.3.1 are given in Table II where the failure definitions are given in 6.2. Failure to meet any one of the maximum allowable percentages of Tables I and II or failure to comply with the test sequence of 3.3.1 the test procedures 3.3.2, the flight qualification requirements of 4.4 or the data requirements of 4.5 shall be cause for lot rejection.

4.3.1.1 Conformance to ND 1015404

Disclosure of any violation of previously agreed to contractor-supplier ND 1015404 "Critical Process" list without prior notification automatically fails the entire lot. Notice of such deviation must be made by the contractor to MIT/IL within 24 hours of disclosure.

4.4 FLIGHT QUALIFICATION

4.4.1 Flight Qualified Hardware

A transistor is flight qualified when the lot, of which the transistor is part, is not rejected according to 4.3.1 and the transistor does not fail any test of the test sequence of paragraph 3.3.1. Lots that failed the criteria of this specification cannot be resubmitted for flight qualification without waiver.

4.4.1.1 Failure Traceability

Any transistor failure detected in qualified flight hardware must be traceable to a lot as identified in paragraph 3.2.1.

4.4.2 Qualification Report

Two copies of a report justifying the acceptance or rejection of a lot as flight qualified shall be forwarded to MIT/IL, prior to use in deliverable end items. The report shall include the following:

a. A copy of the summary of the supplier's Quality Demonstration test.

b. A summary of screen and burn-in data and a detailed list of the screen and burn-in results which includes the number of failures during test sequence 3.3.1.

c. A failure report of all electrical failures, by unit serial number including induced failures, as specified in 4.2.1 which includes:

c1. Photographs of each category of each photographable failure. A minimum of two photographs for each category is required where more than one exists.

c2. Analysis of each failure.

c3. Classification of each failure according to 4.2.2.

d. A failure report by lot of all internal visual inspection failures (test #12 in test sequence 3.3.1) by unit serial number which includes:

d1. Photographs of each failure category detected.
d2. Classification of each failure according to Section 7.

e. Number of failures in the failure mode groups according to 4.2.3.

f. Date of purchase.

g. Allocation of all parts from the lot updated to the date of issue of qualification report indicating the number of units which passed screen and burn-in, the number of failed units, the number of induced failures and the number of units removed from the lot for any other reason.

h. A list of all process changes allowed by the contractor in accordance with 1015404 paragraph 3.3.2.2.

4.5 DATA

4.5.1 Stored Data

Incoming inspection, screen, and burn-in data shall be maintained and stored by lot number for three years.

4.5.2 Cataloging

Transistors failing the tests specified herein with the exception of the external visual inspection and leak tests shall be cataloged and stored by lot number for three years. The devices must be readily accesssible for future reference.

4.5.3 Lot Storage

Units submitted to the contractor as part of the Quality Demonstration Test shall be stored by contractor's lot number for three years. The devices must be readily accessible for future reference.

5. PREPARATION FOR DELIVERY

This section is not applicable to this specification.

6. NOTES

6.1 INTENDED USE

This process conditions transistors used in Apollo Flight Guidance and Navigation Equipment.

6.2 DEFINITIONS

6.2.1 Lot

A lot is defined as a group of transistors submitted by a vendor in compliance with 1006310 or 1006323. All serialized units of that lot and the quality demonstration test as required by 1006310 or 1006323 must be identified with each lot.

6.2.2 Catastrophic Failures

A catastrophic failure is defined as any device which fails the electrical tests by twice the maximum or one half the minimum limits as specified in Table II of SCD's 1006310 and 1006323.

6.2.3 Non-Catastrophic Failures

Non-catastrophic failure is any device which cannot be classed as a catastrophic failure by definition 6.2.2 but which fails according to the definitions described below:

a. A non-catastrophic failure at test 3.3.2.3 exceed the limits of Table II of Specification Control Drawing 1006310 or 1006323 and does not become a catastrophic failure during test sequence 3.3.1.

b. A non-catastrophic failure at test 3.3.2.4 exceeds the limits described in 3.3.2.4 but changes parameters from test 3.3.2.3 by ± 20% or less.

c. A non-catastrophic failure at test 3.3.2.4 does not exceed the limits described in 3.3.2.4, but changes parameters from test 3.3.2.3 by more than ± 20%.

d. A non-catastrophic failure at test 3.3.2.4 exceeds the limits described in 3.3.2.4, but changes parameters from test 3.3.2.3 by more than ± 20%.

e. A non-catastrophic failure at test 3.3.2.12 exceeded a change in DC current gain by ±20% in test sequence 3.3.1 test #9 and test #11.

6.2.4 Induced Failures

An induced failure is a catastrophic failure which through failure analysis can be proven to be caused by exceeding the stress limits of Specification Control Drawing 1006310 or 1006323.

6.2.5 Leak Test Failures

A Failure at test #5 or #6 of paragraph 3.3.1 is failure to meet the leak test limits as specified in Specification Control Drawing 1006310 or 1006323, and failure criteria of MIL-STD-202C, Method 112, Test Condition A.

6.2.6 External Visual Inspection Failures

A failure at test #1 of paragraph 3.3.1 is failure to meet the visual and mechanical examination criteria of Specification Control Drawing 1006310 or 1006323.

6.2.7 Physical Dimension Failures

The physical dimension failures of test #2 of paragraph 3.3.1 is a package which does not meet the physical dimension criteria of specification control drawing 1006310 or 1006323.

6.2.8 Lead Tension, Lead Fatigue Failures

The lead tension, lead fatigue failures of test #2 of paragraph 3.3.1 is a partial or complete severing of a lead from the package.

6.2.9 Internal Visual Inspection Failures

A failure at test #14 of paragraph 3.3.1 is failure to meet the criteria of Section 7.

6.2.10 Failures

Failure of a unit in one or more tests will be charged as a single failure. A unit which could be classed by several failure modes shall be classed in the highest numerical modes as listed in 4.2.2. A unit which meets the definition of 6.2.3 (a) or 6.2.3 (b) or (c) shall be counted in Group 0 only.

7. VISUAL REJECTION CRITERIA

The following defines the internal visual rejection criteria for test #14 for silicon planar transistors.

7.1 HIGH POWER INSPECTION

The following inspection shall be performed at 80 power minimum with a columnated light source applied through the objective lens.

7.1.1 "Purple Plaque"

Any device, when viewed from above exhibiting an intermetallic formation of aluminum and gold (purple plague) is a reject.

7.1.2 Bond Placement

Any device which exhibits bonds whose outer periferies are closer to each other than 0.5 mils is a reject.

7.1.3 Exposed Junction

Any device which exhibits any junction area covered only by unthermally oxidized silicon is a reject.

7.1.4 Cracks in the Die

Any die which exhibits cracks in the active circuit, metalization, or bond areas is a reject. Any die which exhibits cracks 1 mil in length or greater which point toward the active circuit metalization or bonds is a reject.

7.2 LOW POWER INSPECTION

The following inspection shall be performed at 20 power i minimum.

7.2.1 Post Height

Any device which exhibits the post height equal to or less than the top of the chip is a reject.

7.2.2 Lead Length

Leads which exhibit sufficient excess length such that there exists the capability of shorting to another lead, edge or surface of the die, or to the bottom or top of the package without deforming the diameter of the lead shall cause the device to be rejected.

7.2.3 Bonds at the Post

Wedge bonds which are made at the post such that the diameter of the wire at regions where the wire does not make metallurgical contact to the post is constricted to less than 1/2 of the normal wire diameter shall cause the device to be a reject.

7.2.4 Damaged Leads

Any lead which exhibits nicks, cuts, crimps, or scoring which cut into or deform the wire by more than 25% of the original diameter shall cause the device to be a reject.

7.2.5 Conducting Particles

Any device which contains loose or easily removable electrically conducting segments of material which are not part of the device design is a reject. Electrically conducting material shall include any material of sufficient conductance to cause device failure of any electrical specification by shorting contacts.

7.2.6 Surface Coating

Any device which exhibits a surface coating is a reject.

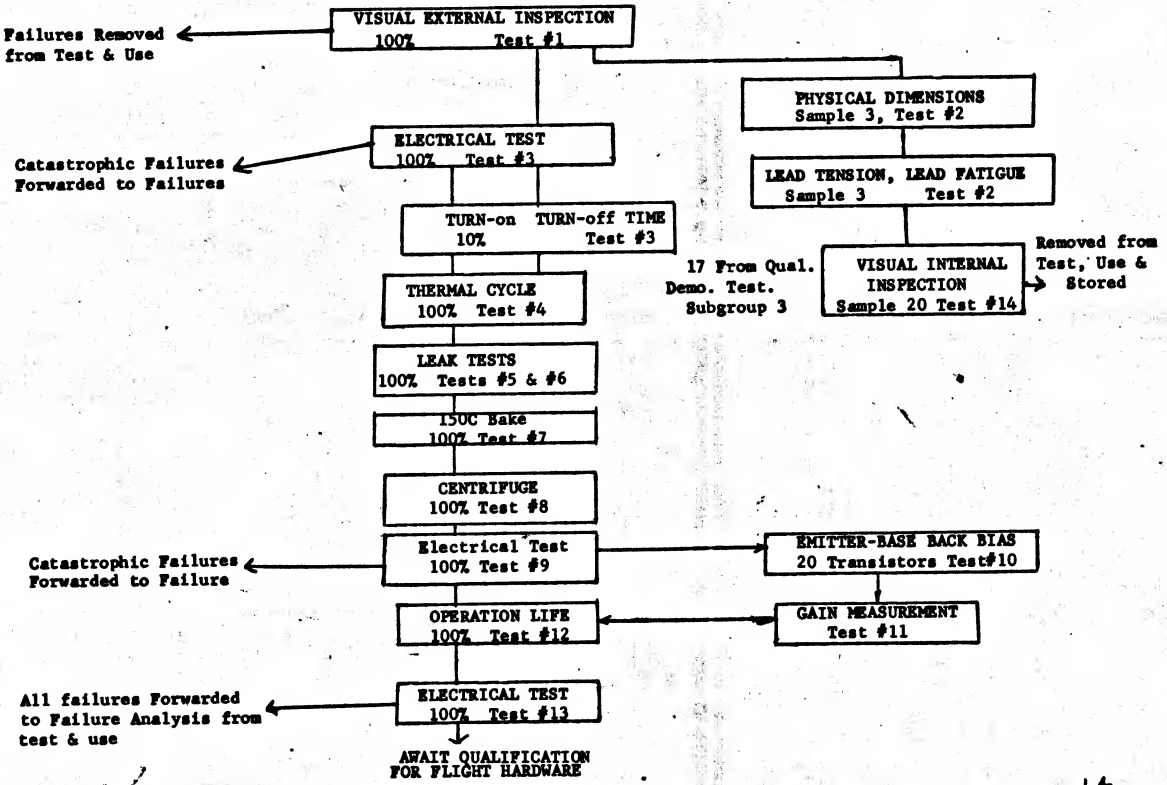
7.2.7 Double Leads

Any device which has more than one bond making electrical contact to any one terminal of the transistor is a reject.

7.2.8 Lead Material

Any device which exhibits lead material greater in length than 2 wire diameters that is fixed only on one end, is a reject.

FLOW DIAGRAM FOR THE TEST SEQUENCE 3.3.1



Apollo G&N Specification
ND 1002271
Original Issue Date:
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Class Release

PROCESS SPECIFICATION FOR
WELDABLE SURFACE, MULTILAYER, PRINTED WIRING BOARDS

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals MIT	Approvals NASA
1/11/66	A	25145	1,2,3,4,5,6,7	WIK	A. C. METZGER

This specification consists of page 1 to 7 inclusive.

APPROVALS	A. C. METZGER NASA/MSC	MIT/IL	AC

W Kuffer CCB 9/MVG

SPECIFICATION FOR
WELDABLE SURFACE, MULTILAYER, PRINTED WIRING BOARDS

1.0 SCOPE

This specification establishes the requirements for material, fabrication, mechanical, and environmental performance requirements for the multilayer, weldable surface, printed wiring board utilizing the plated-thru-hole technique to obtain metallic interlayer connection.

2.0 APPLICABLE DOCUMENTS

The following documents form a part of this specification.

2.1 Specifications

MIL-C-14550 - Copper plating, Electrolytically deposited.
MIL-G-45204 - Gold Plating, Electrolytically deposited.
MIL-P-13949 - Plastic Sheet, Laminated, Copper Clad, (for printed wiring).
MIL-P-18177 - Plastic Sheet Laminated, Thermosetting, Glass fiber base epoxy resin.
MIL-STD-202 - Test Method for Electronic and Electrical Component parts.
ND-1002019 - Marking
Federal Spec. L. T. 90 - Tape, Pressure, - Sensitive Adhesive.
MIL-P-55110 - Printed Wiring Boards

The multilayer boards furnished on this project shall be fabricated and tested to comply with this specification..

3.0 MECHANICAL SPECIFICATIONS

3.1 General Requirements

The multilayer boards, consisting of 7 layers of embedded circuitry, (5 signal layers, 1 ground plane, 1 voltage plane), maximum with weldable tab areas appearing on the top surface and pads on the bottom surface, will be fabricated from a set of artwork masters to meet the requirements of this specification. The lamination layer sequence shall be such that the voltage plane is to be located nearest to the top weld tab layer and the ground plane is to be located nearest the bottom side of the board.

3.2 Specific Requirements

3.2.1 Copper Clad Laminate

The base material shall be 0.008 ± 0.001 inches thick glass fiber base epoxy produced in accordance with MIL-P-18177, type GEE and copper clad to MIL-P-13949, class B pit & dent and class B inclusion. The copper foil shall have a purity of 99.5% and a thickness of .0028+.0007 - .0003 (3 oz)

3.2.2 Weldable Foil

The weldable foil used for the weld-tab areas on the top surface of the board shall be a three layer composite foil consisting of a thin (5%) outer layer of nickel, a relatively thick (90%) core of steel, and a thin (5%) backing of aluminum. The aluminum side shall be bonded to the insulating substrate and shall have a minimum peel strength of 12 lb. per inch of width, when tested in accordance with MIL-P-13949. Foil thickness shall be .003 ± .0003 inches.

3.2.3 Pre-Preg (B-Stage) Material

The pre-preg material used for the fabrication of the boards shall be the same resin system as the copper foil base laminate and shall have a cured thickness of .006 + .001 inches. Two layers of pre-preg material shall be used between copper clad laminates or between the weldable foil and the copper clad laminate. The material shall be per MIL-P-18177, Type GEE after lamination.

3.2.4 Plating

Plating on the surface pad areas or in the holes shall be a combination of the following plating materials.

3.2.4.1 Copper Plating

All copper plating used shall be electrolytically produced in accordance with MIL-C-14550. Minimum purity shall be 99.5%. Electroless deposition of copper adherent to plastic and copper shall be used as a preliminary process for providing the conductive layer inside the holes. The minimum thickness of copper on the wall of the hole shall be .0015 inches. The plating thickness shall be determined by examination of micro-sections of plated-thru-holes located in a test cupon area adjacent to the board. The manufacturer shall be required to keep on record for a period of one year, micro-sections of the plated-thru-holes.

3.2.4.2 Gold Plating

All gold plating used shall be electrolytically deposited in accordance with MIL-G-45204, Type I or II. The minimum thickness of gold shall be .000050 inches. Type II gold shall be preferred.

3.2.5 Conductor Width and Spacing

Nominal conductor width on internal layer shall be .015 inches. In critical applications, where circuit parameters permit, the conductor width shall be .010 inches minimum. Conductor defects such as pin holes, pits, nicks, or ragged edges shall not reduce the effective width of the conductor more than 25%, as long as the conductor width has not been reduced below the minimum allowable conductor width of .010 inches. Minimum conductor spacing between conductors, pad areas, or between a conductor and the wall of a plated-thru-hole shall be .010 inches.

3.2.6 Weldable Tab Area

The weldable tab area with their associated holes shall be as defined in figure 1. The minimum spacing between weldable tab areas shall be .010".

3.2.7 Pad Area

In the manufactured board, the minimum annular ring on external pads on the bottom of the board, or the distance between the edge of the pad and the edge of the plated-thru-hole shall be .002 inches. The minimum spacing between adjacent pads shall be .010".

3.2.8 Registration

The layer-to-layer registration shall be within .005 inches from true location. for internal layers.

3.2.9 Component Identification

Markings shall be epoxy base ink (black) per ND 1002019.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 General Requirements

The boards furnished in accordance with this specification and all associated drawings shall be accepted on the basis of this test specification.

4.2 Workmanship Requirements

The multilayer circuit board shall be manufactured in a careful workmanship manner to meet the requirements of this overall specification. The finished board shall be uniform in texture, finish, and be free of blisters, wrinkles, pin holes, or delamination, which may affect the serviceability or function of the board.

4.3 Physical Requirements

4.3.1 Machineability

The board shall be capable of withstanding drilling and routing in all directions without cracking, splitting or delamination. The finished length and width of the board shall be routed to 9.000" $\pm$.010" by 1.063 $\pm$.010".

4.3.2 Warp or Twist

The warp or twist of the board shall not exceed .020" on overall length

4.3.3 Plating Adhesion

A plating adhesion test using cellophane tape conforming to Type 1, Class A, Federal Specification LT 90 shall be performed on all plated circuitry in conformance with MIL-P-55110.

4.3.4 Weldability

The board shall be capable of withstanding the heating effects produced by a parallel-gap welder. No delamination of the weld tab shall occur; slight epoxy melt is permissible in the area of the weld joint.

4.3.5 Re-Weldability

The board shall be capable of withstanding the replacement of any individual component a minimum of 3 times without delamination of the weld-tab.

4.4 Electrical Requirements

The multilayer board shall be tested and must be capable of withstanding the following electrical tests.

4.4.1 Electrical Continuity

Each board shall be 100% checked for electrical continuity and shorts. The dc resistance of any conductor shall be less than 4 ohms. (0.3 ohm attributable to the conductor and the balance of 3.7 ohms to test fixturing.)

4.4.2 Insulation Resistance

The insulation resistance between each conductor and all other conductors shall be not less than 30 megohms with 100 VDC. There shall be no flash-over, sparkover, or any other disruptive discharge. The circuit shall be tested in accordance with MIL-STD-202, Method 302.

4.5 Environmental Specifications

4.5.1 Performance Capability

The multilayer board will be capable of withstanding the effects of any combination of environmental conditions defined herein without loss of continuity, breakdown between conductors, delamination of circuitry layers, delamination of the weldable tabs and base material, or any visible damage to the board. Discoloration of the metallic conductors and epoxy board is permissible.

4.5.2 Temperature, Vibration and Thermal Shock

The multilayer board shall withstand the temperature, vibration and thermal shock in accordance with MIL-STD-202, Methods 107B and 204A, and in the following sequence:

1. Thermal Shock: 5 cycles, 30 minutes residence at extremes of -65°C (-85°F) and + 165°C (+329°F).
2. Thermal storage at + 165°C (+ 329°F) for 15 hours.
3. Thermal storage at -65°C (-85°F) for 8 hours.
4. Vibration: 8.5 minute sweep at approximately 1 octave/1.5min. From 30 to 2000 cps with 7.5G sine wave, plus 15 grms Noise A 6db roll-off is permitted between 30 to 60 cps.
5. Vibration: 8.5 minute sweep at approximately 1 octave/1.5 min. From 2000 to 30 cps with 15G sine wave only.
6. Vibration 8.5 minute sweep at approximately 1 octave/1.5 min. From 30 to 2000 cps with 10G sine wave, plus 20 grms noise. A 6 db roll-off is permitted between 30 to 60 cps.
7. Vibration 8.5 minute sweep at approximately 1 octave/1.5 min. From 2000 to 30 cps with 10G sine wave only.
8. Thermal shock: 5 cycles, 30 minutes residence at extremes of -65°C (-85°F) and +165°C (+ 329°F).

NOTE: Board to be mounted horizontal and parallel with the vibration fixture. The board shall be clamped both top and bottom along entire long axis for a depth of approx. 1/8 inch from both edges.

4.5.3 Humidity

The multilayer board, after being coated with a conformal coating, shall be tested in accordance with MIL-STD-202B, Method 106 (A) (except Step 7); +25°C. to 65°C, 90-98% RH, ten 16-hour-cycles, 100 Vdc polarizing voltage applied.

4.6 Design Requirements

4.6.1 Capacitance

The capacitance of each board shall meet the following requirements:

a. Signal circuit to signal circuit - 55 Picofarads Max.

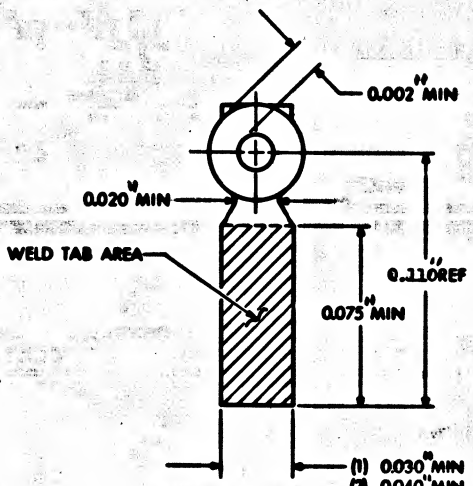
b. Signal circuit to all other (tie - 100 Picofarads Max.
all other leads including ground
and voltage together).

c. Voltage plane to ground plane - no limit.

5.0 Preparation for Delivery This section is not applicable to this specification.

6.0 NOTES

6.1 Intended Use. This process is intended for use in the fabrication of multilayer circuit boards for use in the Airborne Apollo Guidance and Navigation equipment.



(1) MODULE TABS
(2) INPUT-OUTPUT TABS

Figure 1

Apollo G&N Specification
ND 1002271
Original Issue Date:
Release Authority: TDRR 23930
Class A Release

PROCESS SPECIFICATION FOR
WELDABLE SURFACE, MULTILAYER, PRINTED WIRING BOARDS

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals MIT	Approvals NASA
1/11/66	A	25145	1,2,3,4,5,6,7	WH	A. C. METZGER
(M) 3/30/66	B	27197	1, 2, 3, 4, 7		

This specification consists of page 1 to 7 inclusive.

APPROVALS	A. C. METZGER NASA/MSC	R Lawson 11/9/65 MIT/IL W R Turner 11/9/65 W Kupfer CCB 9Nov65	AC

SPECIFICATION FOR
WELDABLE SURFACE, MULTILAYER, PRINTED WIRING BOARDS

1.0 SCOPE

This specification establishes the requirements for material, fabrication, mechanical, and environmental performance requirements for the multilayer, weldable surface, printed wiring board utilizing the plated-thru-hole technique to obtain metallic interlayer connection.

2.0 APPLICABLE DOCUMENTS

The following documents form a part of this specification.

2.1 Specifications

MIL-C-14550 - Copper plating, Electrolytically deposited.
MIL-G-45204 - Gold Plating, Electrolytically deposited.
MIL-P-13949 - Plastic Sheet, Laminated, Copper Clad, (for printed wiring).
MIL-P-18177 - Plastic Sheet Laminated, Thermosetting, Glass fiber base epoxy resin.
MIL-STD-202 - Test Method for Electronic and Electrical Component parts.
ND-1002019 - Marking
Federal Spec. L. T. 90 - Tape, Pressure, - Sensitive Adhesive.
MIL-P-55110 - Printed Wiring Boards

The multilayer boards furnished on this project shall be fabricated and tested to comply with this specification.

3.0 MECHANICAL SPECIFICATIONS

3.1 General Requirements

The multilayer boards, consisting of a sufficient number of layers of embedded circuitry with weldable tab areas appearing on the top surface and on the bottom surface, will be fabricated from a set of artwork masters to meet the requirements of this specification. The lamination layer sequence shall be such that the voltage plane is to be located nearest to the top weld tab layer and the ground plane is to be located nearest the bottom side of the board.

3.2 Specific Requirements

3.2.1 Copper Clad Laminate

The base material shall be 0.008 ± 0.001 inches thick glass fiber base epoxy produced in accordance with MIL-P-18177, type GEE and copper clad to MIL-P-13949, class B pit & dent and class B inclusion. The copper foil

shall have a purity of 99.5% and a thickness of .0028 + .0007 - .0003 (2 oz).

3.2.2 Weldable Foil

The weldable foil used for the weld-tab areas on the top surface of the board shall be a three layer composite foil consisting of a thin (5%) outer layer of nickel, a relatively thick (90%) core of steel, and a thin (5%) backing of aluminum. The aluminum side shall be bonded to the insulating substrate and shall have a minimum peel strength of 12 lb. per inch of width, when tested in accordance with MIL-P-13949. Foil thickness shall be .003 ± .0003 inches.

3.2.3 Pre-Preg (B-Stage) Material

The pre-preg material used for the fabrication of the boards shall be the same resin system as the copper foil base laminate and shall have a cured thickness of .006 ± .001 inches. Pre-preg material shall be used between copper clad laminates or between the weldable foil and the copper clad laminate. The material shall be per MIL-P-18177, Type GEE after lamination.

3.2.4 Plating

Plating on the surface pad areas or in the holes shall be a combination of the following plating materials.

3.2.4.1 Copper Plating

All copper plating used shall be electrolytically produced in accordance with MIL-C-14550. Minimum purity shall be 99.5%. Electroless deposition of copper adherent to plastic and copper shall be used as a preliminary process for providing the conductive layer inside the holes. The minimum plated copper thickness in the plated thru holes shall be .0015 inches for 75 percent of the cross sectional hole. The remaining 25 percent may exhibit a maximum of 3 of the following conditions on each side of a hole.

1. An area which has a minimum plated thickness of .0005 inches and a maximum length of .002 inches, provided it does not appear at the hole conductor interface, and a similar condition does not appear on the adjacent side of the hole indicating a ring.

2. An area which has a minimum plated thickness of .001 inches and a maximum length of .005 inches, provided it does not appear at the hole conductor interface.

The plating thickness shall be determined by examination of micro-sections of plated-thru-holes located in a test cupon area adjacent to the board. The manufacturer shall be required to keep on record for a period of one year, micro-sections of the plated-thru-holes.

3.2.4.2 Gold Plating

All gold plating used shall be electrolytically deposited in accordance with MIL-G-45204, Type I or II. The minimum thickness of gold shall be .000050 inches. Type II gold shall be preferred.

3.2.5 Conductor Width and Spacing

Nominal conductor width on internal layer shall be .015 inches. In critical applications, where circuit parameters permit, the conductor width shall be .010 inches minimum. Conductor defects such as pin holes, pits, nicks, or ragged edges shall not reduce the effective width of the conductor more than 25%, as long as the conductor width has not been reduced below the minimum allowable conductor width of .010 inches. Minimum conductor spacing between conductors, pad areas, or between a conductor and the wall of a plated-thru-hole shall be .010 inches.

3.2.6 Weldable Tab Area

The weldable tab area with their associated holes shall be as defined in figure 1. The minimum spacing between weldable tab areas shall be .010".

3.2.7 Pad Area

In the manufactured board, the minimum width of the annular ring on external pads on the bottom of the board, or the distance between the edge of the pad and the edge of the plated-thru-hole shall be .002 inches. The minimum spacing between adjacent pads shall be .010".

3.2.8 Registration

The layer-to-layer registration shall be within .005 inches from true location for internal layers.

3.2.9 Component Identification

Markings shall be epoxy base ink (black) per ND 1002019.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 General Requirements

Boards shall be accepted on the basis of conformance to this specification and all related drawings and documents mentioned on page one. In the event of conflict between the requirements of the applicable drawings, this specification and other documents cited herein, the requirements of the applicable drawings and this specification shall govern in that order.

4.2 Workmanship Requirements

The multilayer circuit board shall be manufactured in a careful workmanship manner to meet the requirements of this overall specification. The finished board shall be uniform in texture, finish, and be free of blisters, wrinkles, pin holes, or delamination, which may affect the serviceability or function of the board.

4.3 Physical Requirements

4.3.1 Machineability

The board shall be capable of withstanding drilling and routing in all directions without cracking, splitting or delamination. The finished length and width of the board shall be routed to 9.000" ± .010" by 1.063 + .010".

4.3.2 Warp or Twist

The warp or twist of the board shall not exceed .090" on overall length.

4.3.3 Plating Adhesion

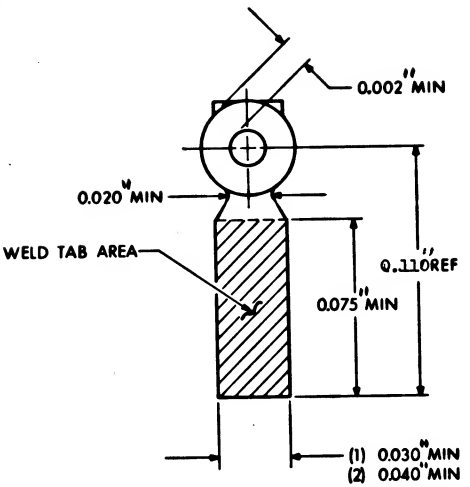
A plating adhesion test using cellophane tape conforming to Type 1, Class A, Federal Specification LT 90 shall be performed on all plated circuitry in conformance with MIL-P-55110.

4.3.4 Weldability

The board shall be capable of withstanding the heating effects produced by a parallel-gap welder. No delamination of the weld tab shall occur; slight epoxy melt is permissible in the area of the weld joint.

4.3.5 Re-Weldability

The board shall be capable of withstanding the replacement of any individual component a minimum of 3 times.



#77 (.018) dia. drilled hole, plated thru.

(1) MODULE TABS
(2) INPUT-OUTPUT TABS

Figure 1

Apollo G&N Specification
ND 1002271
Original Issue Date:
Release Authority: TDRR 23930
Class A Release

PROCESS SPECIFICATION FOR
WELDABLE SURFACE, MULTILAYER, PRINTED WIRING BOARDS

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals MIT	Approvals NASA
1/4/66	A	25145	1,2,3,4,5,6,7	WL	A. C. METZGER
3/30/66	B	27197	1, 2, 3, 4, 7		
4/12/66	C	27938	2, 3		

This specification consists of page 1 to 7 inclusive.

APPROVALS	A. C. METZGER NASA/MSC	MIT/IL	AC

W Kaufer CCB 9 Nov 65

shall have a purity of 99.5% and a thickness of .0028 + .0007 - .0003 (2 oz).

3.2.2 Weldable Foil

The weldable foil used for the weld-tab areas on the top surface of the board shall be a three layer composite foil consisting of a thin (5%) outer layer of nickel, a relatively thick (90%) core of steel, and a thin (5%) backing of aluminum. The aluminum side shall be bonded to the insulating substrate and shall have a minimum peel strength of 12 lb. per inch of width, when tested in accordance with MIL-P-13949. Foil thickness shall be .003 ± .0003 inches.

3.2.3 Pre-Preg (B-Stage) Material

The pre-preg material used for the fabrication of the boards shall be the same resin system as the copper foil base laminate and shall have a cured thickness of .006 ± .001 inches. Pre-preg material shall be used between copper clad laminates or between the weldable foil and the copper clad laminate. The material shall be per MIL-P-18177, Type GEE after lamination.

3.2.4 Plating

Plating on the surface areas or in the holes shall be a combination of the following plating materials.

3.2.4.1 Copper Plating

All copper plating used shall be electrolytically produced in accordance with MIL-C-14550. Minimum purity shall be 99.5%. Electroless deposition of copper adherent to plastic and copper shall be used as a preliminary process for providing the conductive layer inside the holes. The minimum plated copper thickness in the plated thru holes shall be .0015 inches for 75 percent of the cross sectional hole. The remaining 25 percent may exhibit a maximum of 3 of the following conditions on each side of a hole.

1. An area which has a minimum plated thickness of .0005 inches and a maximum length of .002 inches, provided it does not appear at the hole conductor interface, and a similar condition does not appear on the adjacent side of the hole indicating a ring.

2. An area which has a minimum plated thickness of .001 inches and a maximum length of .005 inches, provided it does not appear at the hole conductor interface.

The plating thickness shall be determined by examination of micro-sections of plated-thru-holes located in a test cupon area adjacent to the board. The manufacturer shall be required to keep on record for a period of one year, micro-sections of the plated-thru-holes.

3.2.4.2 Gold Plating Plated Through Holes

Gold plating shall be electrolytically deposited in accordance with MIL-G-45204, Type I or II. The minimum thickness of gold shall be .000050 inches. Type II gold shall be preferred.

3.2.4.3 Gold Plating Weldable Tabs

Gold plating shall be electrolytically deposited in accordance with MIL-G-45204, Type I. The thickness of gold shall be 0.0001 inches minimum to 0.0003 inches maximum.

3.2.5 Conductor Width and Spacing

Nominal conductor width on internal layer shall be .015 inches. In critical applications, where circuit parameters permit, the conductor width shall be .010 inches minimum. Conductor defects such as pin holes, pits, nicks, or ragged edges shall not reduce the effective width of the conductor more than 25%, as long as the conductor width has not been reduced below the minimum allowable conductor width of .010 inches. Minimum conductor spacing between conductors, pad areas, or between a conductor and the wall of a plated-thru-hole shall be .010 inches.

3.2.6 Weldable Tab Area

The weldable tab area with their associated holes shall be as defined in figure 1. The minimum spacing between weldable tab areas shall be .010".

3.2.7 Pad Area

In the manufactured board, the minimum width of the annular ring on external pads on the bottom of the board, or the distance between the edge of the pad and the edge of the plated-thru-hole shall be .002 inches. The minimum spacing between adjacent pads shall be .010".

3.2.8 Registration

The layer-to-layer registration shall be within .005 inches from true location for internal layers.

3.2.9 Component Identification

Markings shall be epoxy base ink (black) per ND 1002019.

Apollo G&N Specification
ND 1002271
Original Issue Date:
Release Authority: TDRR 23930
Class A Release

PROCESS SPECIFICATION FOR
WELDABLE SURFACE, MULTILAYER, PRINTED WIRING BOARDS

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals MIT	Approvals NASA
1/11/66	A	25145	1,2,3,4,5,6,7	WH	A. C. METZGER
(M) 3/30/66	B	27197	1, 2, 3, 4, 7		
4/12/66	C	27938	2, 3		
(M) 10/27/66	D	32999	1, 2, 4, 5		

This specification consists of page 1 to 7 inclusive.

APPROVALS	A. C. METZGER NASA/MSC	11/9/65 MIT/IL 11/9/65 W Ruffer CCB 9/NOV65	AC

SPECIFICATION FOR
WELDABLE SURFACE, MULTILAYER, PRINTED WIRING BOARDS

1.0 SCOPE

This specification establishes the requirements for material, fabrication, mechanical, and environmental performance requirements for the multilayer, weldable surface, printed wiring board utilizing the plated-thru-hole technique to obtain metallic interlayer connection.

2.0 APPLICABLE DOCUMENTS

The following documents form a part of this specification.

2.1 Specifications

MIL-C-14550 - Copper plating, Electrolytically deposited.
MIL-G-45204 - Gold Plating, Electrolytically deposited.
MIL-P-13949 - Plastic Sheet, Laminated, Copper Clad, (for printed wiring).
MIL-P-18177 - Plastic Sheet Laminated, Thermosetting, Glass fiber base epoxy resin.
MIL-STD-202 - Test Method for Electronic and Electrical Component parts.
ND-1002019 - Marking
Federal Spec. L. T. 90 - Tape, Pressure, - Sensitive Adhesive.
MIL-P-55110 - Printed Wiring Boards

The multilayer boards furnished on this project shall be fabricated and tested to comply with this specification.

3.0 MECHANICAL SPECIFICATIONS

3.1 General Requirements

The multilayer boards, consisting of a sufficient number of layers of embedded circuitry with weldable tab areas appearing on the top surface will be fabricated from a set of artwork masters to meet the requirements of this specification. The lamination layer sequence shall be such that the voltage plane is to be located nearest to the top weld tab layer and the ground plane is to be located nearest the bottom side of the board.

3.2 Specific Requirements

3.2.1 Copper Clad Laminate

The base material shall be 0.008 ± 0.001 inches thick glass fiber base epoxy produced in accordance with MIL-P-18177, type GEE and copper clad to MIL-P-13949, class B pit & dent and class B inclusion. The copper foil

shall have a purity of 99.5% and a thickness of .0028 +.0007 - .0003 (2 oz).

3.2.2 Weldable Foil

The weldable foil used for the weld-tab areas on the top surface of the board shall be a three layer composite foil consisting of a thin (5%) outer layer of nickel, a relatively thick (90%) core of steel, and a thin (5%) backing of aluminum. The aluminum side shall be bonded to the insulating substrate and shall have a minimum peel strength of 12 lb. per inch of width when tested in accordance with MIL-P-13949. Foil thickness shall be .003 ± .0003 inches.

3.2.3 Pre-Preg (B-Stage) Material

The pre-preg material used for the fabrication of the boards shall be the same resin system as the copper foil base laminate and shall have a cured thickness of .006 ± .001 inches. Pre-preg material shall be used between copper clad laminates or between the weldable foil and the copper clad laminate. The material shall be per MIL-P-18177, Type GEE after lamination.

3.2.4 Plating

Plating on the surface areas or in the holes shall be a combination of the following plating materials.

3.2.4.1 Copper Plating

All copper plating used shall be electrolytically produced in accordance with MIL-C-14550. Minimum purity shall be 99.5%. Electroless deposition of copper adherent to plastic and copper shall be used as a preliminary process for providing the conductive layer inside the holes. The minimum plated copper thickness in the plated thru holes shall be .0015 inches for 75 percent of the cross sectional hole. The remaining 25 percent may exhibit a maximum of 3 of the following conditions on each side of a hole.

1. An area which has a minimum plated thickness of .001 inches and a maximum length of .005 inches, provided it does not appear at the hole conductor interface.

The plating thickness shall be determined by examination of micro-sections of plated-thru-holes located in a test cupon area adjacent to the board. The manufacturer shall be required to keep on record for a period of one year, micro-sections of the plated-thru-holes.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 General Requirements

Boards shall be accepted on the basis of conformance to this specification and all related drawings and documents mentioned on page one. In the event of conflict between the requirements of the applicable drawings, this specification and other documents cited herein, the requirements of the applicable drawings and this specification shall govern in that order.

4.2 Workmanship Requirements

The multilayer circuit board shall be manufactured in a careful workmanship manner to meet the requirements of this overall specification. The finished board shall be uniform in texture, finish, and be free of blisters, wrinkles, pin holes, or delamination, which may affect the serviceability or function of the board.

4.3 Physical Requirements

4.3.1 Machineability

The board shall be capable of withstanding drilling and routing in all directions without cracking, splitting or delamination. The finished length and width of the board shall be routed to 9.000" ± .010" by 1.063 + .010".

4.3.2 Warp or Twist

The warp or twist of the board shall not exceed .090" on overall length.

4.3.3 Plating Adhesion

A plating adhesion test using cellophane tape conforming to Type 1, Class A, Federal Specification LT 90 shall be performed on all plated circuitry in conformance with MIL-P-55110.

4.3.4 Weldability

The board shall be capable of withstanding the heating effects produced by a parallel-gap welder. No delamination of the weld tab shall occur; slight epoxy melt is permissible in the area of the weld joint.

Apollo G&N Specification
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Release Authority: TDRR 23930
Class Release

PROCESS SPECIFICATION FOR
WELDABLE SURFACE, MULTILAYER, PRINTED WIRING BOARDS

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals MIT	Approvals NASA

This specification consists of page 1 to 7 inclusive.

APPROVALS	A. C. METZGER NASA/MSC	R Langmuir 11/9/65 J R Eyles MIT/IL W K Turner 11/9/65 W Kepfer CCB 9 NOV 65	AC

SPECIFICATION FOR
WELDABLE SURFACE, MULTILAYER, PRINTED WIRING BOARDS

1.0 SCOPE

This specification establishes the requirements for material, fabrication, mechanical, and environmental performance requirements for the multilayer, weldable surface, printed wiring board utilizing the plated-thru-hole technique to obtain metallic interlayer connection.

2.0 APPLICABLE DOCUMENTS

The following documents form a part of this specification.

2.1 Specifications

MIL-C-14550 - Copper plating, Electrolytically deposited.
MIL-G-45204 - Gold Plating, Electrolytically deposited.
MIL-P-13949 - Plastic Sheet, Laminated, Copper Clad, (for printed wiring).
MIL-P-18177 - Plastic Sheet Laminated, Thermosetting, Glass fiber base epoxy resin.
MIL-STD-202 - Test Method for Electronic and Electrical Component parts.
ND-1002019 - Marking
Federal Spec. L. T. 90 - Tape, Pressure, - Sensitive Adhesive.
MIL-P-55110 - Printed Wiring Boards

The multilayer boards furnished on this project shall be fabricated and tested to comply with this specification..

3.0 MECHANICAL SPECIFICATIONS

3.1 General Requirements

The multilayer boards, consisting of 7 layers of embedded circuitry, (5 signal layers, 1 ground plane, 1 voltage plane), maximum with weldable tab areas appearing on the top surface and pads on the bottom surface, will be fabricated from a set of artwork masters to meet the requirements of this specification. The lamination layer sequence shall be such that the voltage plane is to be located nearest to the top weld tab layer and the ground plane is to be located nearest the bottom side of the board.

3.2 Specific Requirements

3.2.1 Copper Clad Laminate

The base material shall be glass fiber base epoxy per MIL-P-13949, Type GF10, and shall have a thickness of .008 + .001 inches. The copper foil shall have a purity of 99.5% and a thickness of .0028 + .0007 -.0003 (2 oz.).

3.2.2 Weldable Foil

The weldable foil used for the weld-tab areas on the top surface of the board shall be a three layer composite foil consisting of a thin (5%) outer layer of nickel, a relatively thick (90%) core of steel, and a thin (5%) backing of aluminum. The aluminum side shall be bonded to the insulating substrate and shall have a minimum peel strength of 12 lb. per inch of width. Foil thickness shall be .003 ± .0003 inches.

3.2.3 Pre-Preg (B-Stage) Material

The pre-preg material used for the fabrication of the boards shall be the same resin system as the copper foil base laminate and shall have a cured thickness of .006 ± .001 inches. Two layers of pre-preg material shall be used between copper clad laminates or between the weldable foil and the copper clad laminate. The material shall be per MIL-P-18177, Type GEE.

3.2.4 Plating

Plating on the surface pad areas or in the holes shall be a combination of the following plating materials.

3.2.4.1 Copper Plating

All copper plating used shall be electrolytically produced in accordance with MIL-C-14550. Minimum purity shall be 99.5%. Electroless deposition of copper adherent to plastic and copper shall be used as a preliminary process for providing the conductive layer inside the holes. The minimum thickness of copper on the wall of the hole shall be .0015 inches. The plating thickness shall be determined by examination of micro-sections of plated-thru-holes located in a test cupon area adjacent to the board. The manufacturer shall be required to keep on record for a period of one year, micro-sections of the plated-thru-holes.

3.2.4.2 Gold Plating

All gold plating used shall be electrolytically deposited in accordance with MIL-G-45204, Type I or II. The minimum thickness of gold shall be .000050 inches. Type II gold shall be preferred.

3.2.5 Board Thickness

The measurement of the composite board thickness shall be made across the board cross-section extremities, including plating on the surface and epoxy coating on the bottom. The composite board thickness shall not exceed .125 inches.

3.2.6 Conductor Width and Spacing

Nominal conductor width on internal layer shall be .015 inches. In critical applications, where circuit parameters permit, the conductor width shall be .010 inches minimum. Conductor defects such as pin holes, pits, nicks, or ragged edges shall not reduce the effective width of the conductor more than 25%, as long as the conductor width has not been reduced below the minimum allowable conductor width of .010 inches. Minimum conductor spacing between conductors, pad areas, or between a conductor and the wall of a plated-thru-hole shall be .010 inches.

3.2.7 Weldable Tab Area

The weldable tab area with their associated holes shall be as defined in figure 1. The minimum spacing between weldable tab areas shall be .010".

3.2.8 Pad Area

In the manufactured board, the minimum annular ring on external pads on the bottom of the board, or the distance between the edge of the pad and the edge of the plated-thru-hole shall be .002 inches. The minimum spacing between adjacent pads shall be .010".

3.2.9 Registration

The layer-to-layer registration shall be within .005 inches from true location.

3.2.10 Component Identification

Markings shall be epoxy base ink (black) per ND 1002019.

3.2.10.1 Component Orientation

The orientation of the integrated circuit component shall be stenciled on the top surface of the board.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 General Requirements

The boards furnished in accordance with this specification and all associated drawings shall be accepted on the basis of this test specification.

4.2 Workmanship Requirements

The multilayer circuit board shall be manufactured in a careful workmanship manner to meet the requirements of this overall specification. The finished board shall be uniform in texture, finish, and be free of blisters, wrinkles, pin holes, or delamination, which may affect the serviceability or function of the board.

4.3 Physical Requirements

4.3.1 Machineability

The board shall be capable of withstanding drilling and routing in all directions without cracking, splitting or delamination. The finished length and width of the board shall be routed to 9.000" $\pm$.010" by 1.063 $\pm$.010".

4.3.2 Warp or Twist

The warp or twist of the board shall not exceed .010 inch/inch.

4.3.3 Plating Adhesion

A plating adhesion test using cellophane tape conforming to Type 1, Class A, Federal Specification LT 90 shall be performed on all plated circuitry in conformance with MIL-P-55110.

4.3.4 Weldability

The board shall be capable of withstanding the heating effects produced by a parallel-gap welder. No delamination of the weld tab shall occur; slight epoxy melt is permissible in the area of the weld joint.

4.3.5 Re-Weldability

The board shall be capable of withstanding the replacement of any individual component a minimum of 3 times without delamination of the weld-tab.

4.4 Electrical Requirements

The multilayer board shall be tested and must be capable of withstanding the following electrical tests.

4.4.1 Electrical Continuity

Each board shall be 100% checked for electrical continuity and shorts. The dc resistance of any conductor shall be less than 0.3 ohms.

4.4.2 Insulation Resistance

The insulation resistance between each conductor and all other conductors shall be not less than 30 megohms with 100 VDC. There shall be no flashover, sparkover, or any other disruptive discharge. The circuit shall be tested in accordance with MIL-STD-202, Method 302.

4.4.3 Capacitance

The capacitance of the boards shall be checked and shall meet the following requirements:

a. Signal circuit to signal circuit - 55 Picofarads Max.

b. Signal circuit to all other (tie all other leads including ground and voltage together). - 100 Picofarads Max.

c. Voltage plane to ground plane - no limit.

4.5 ENVIRONMENTAL SPECIFICATIONS

4.5.1 Performance Capability

The multilayer board will be capable of withstanding the effects of any combination of environmental conditions defined herein without loss of continuity, breakdown between conductors, delamination of circuitry layers, delamination of the weldable tabs and base material, or any visible damage to the board. Discoloration of the metallic conductors and epoxy board is permissible.

4.5.2 Temperature, Vibration and Thermal Shock

The multilayer board shall withstand the temperature, vibration and thermal shock in accordance with MIL-STD-202, Methods 107A and 204A, and the following schedule:

1. Thermal storage at +165°C. for 15 hours.

2. Thermal storage at -65°C. (-85°F.) for 8 hours.

3. Thermal shock, 5 cycles, 30 minutes residence at extremes of -65°C (-85°F) and +165°C.

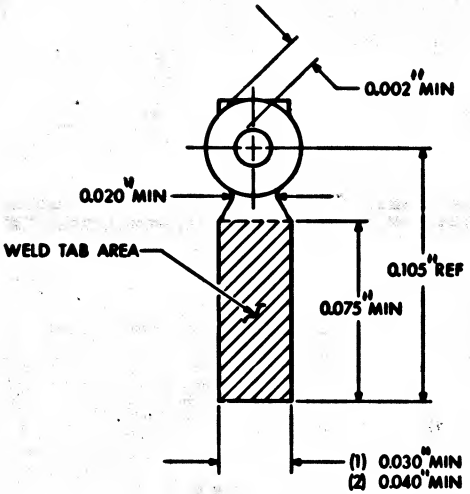
4.5.3 Humidity

The multilayer board, after being coated with a conformal coating, shall be tested in accordance with MIL-STD-202B, Method 106 (A) (except Step 7); +25°C. to 65°C, 90-98% RH, ten 16-hour-cycles, 100 Vdc polarizing voltage applied.

5.0 PREPARATION FOR DELIVERY. This section is not applicable to this specification.

6.0 NOTES

6.1 Intended Use. This process is intended for use in the fabrication of multilayer circuit boards for use in the Airborne Apollo Guidance and Navigation equipment.



(1) MODULE TABS
(2) INPUT-OUTPUT TABS

Figure 1

7-2-65

APOLLO G&N Specification
ND1002274 REV. A
Original Issue Date:
Release Authority: TDRR 25378
Class A Release
CODE IDENT NO. 80230

TEST SPECIFICATION

IMU AND PIPA ELECTRONICS ASSEMBLY

WORKMANSHIP-VIBRATION

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA
4/5/66	A	27766	3, 6 RW \| RW	WK	--

This specification consists of page 1 to 7 inclusive.

APPROVALS	A. C. METZGER NASA/MSC	EJB WK [signature]	J. MILLER FROM TDRR WK R	[signature] ACSP

3. REQUIREMENTS

3.1 PRECAUTIONS. Normal safety precautions required during testing of precision electromechanical equipment shall be followed.

3.1.1 Heater Power. Electrical power shall be supplied to the assembly such that the temperatures of the three IRIG's shall be maintained at 135° ±5°F, and the temperature of the three PIP's shall be maintained at 130° ±5°F. Momentary disconnects of heater power to the inertial components at operating temperature are allowed for periods of up to 5 minutes.

3.1.2 Ducosyn Suspension Power. The ducosyn suspension power shall be maintained for a period of 2 hours prior to pulse torquing. If suspension power is interrupted after initial turn on and prior to completion of the 2-hour period, an additional period of suspension on-time equivalent to the suspension interruption-time period shall be required before pulse torquing.

3.2 TEST CONDITIONS. The workmanship-vibration tests shall be performed under the following conditions:

3.2.1 Test Environment

a. Ambient Temperature: 25° ±10°C
b. Relative Humidity: 90% max
c. Barometric Pressure: 28 to 32 inches of Hg

3.2.2 Electrical Input. The simulated S/C ISS operate bus shall be 28.30±0.25 vdc.

3.2.3 Coolant Requirements. The IMU shall be provided with water-glycol coolant at a temperature of 45° ±3°F and flow rate of 33±3 lb per hour. In addition, the PSA, and PIPA Coldplates shall be provided with coolant sufficient to maintain the header temperatures below 70°F.

3.2.4 Gyro Wheel Time. A record shall be kept of gyro wheel operation time.

3.3 PRIOR COMPLIANCE. Prior to performing the workmanship-vibration test on the assembly, an Inertial Subsystem, including the assembly to be tested, shall have been calibrated and tested in accordance with ATP2015497 or PS2007203.

3.4 SUPPORT EQUIPMENT. The Power and Servo Assembly (PSA) which was tested and calibrated with the assembly in accordance with ATP2015497 (see 3.3) shall be used with the assembly during vibration testing.

3.5 TEST FAILURE

3.5.1 Failure Criteria. Failure of the assembly to perform as specified herein, failure of materials, instability of circuits, chattering of contacts, insulation breakdown or permanent change of components which would affect operational and reliability performance of the APOLLO Guidance and Navigation Equipment shall constitute failure of the assembly.

7-2-65

APOLLO G&N Specification
ND1002274 REV. B
Original Issue Date:
Release Authority: TDRR 25378
Class A Release
CODE IDENT NO. 80230

TEST SPECIFICATION

IMU AND PIPA ELECTRONICS ASSEMBLY

WORKMANSHIP-VIBRATION

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals MIT	Approvals NASA
4/5/66	A	27766	3, 6 RDG \| RC	WK	--
5/17/66	B	28903	3 JHIAC	MGM	---

This specification consists of page 1 to 7 inclusive.

APPROVALS	A. C. METZGER NASA/MSC	WK 5/6/66 for MIT/IL	J. MILLER FROM TDRR WK 5/17/66	ACSP

7-2-65

APOLLO G&N Specification
ND1002274 REV.
Original Issue Date:
Release Authority: TDRR 25378
Class A Release
CODE IDENT NO. 80230

TEST SPECIFICATION

IMU AND PIPA ELECTRONICS ASSEMBLY

WORKMANSHIP-VIBRATION

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA

This specification consists of page 1 to 7 inclusive.

APPROVALS	A. C. METZGER NASA/MSC		J. MILLER FROM TPDA MIT/IL		ACSP

1. SCOPE

1.1 PURPOSE. This specification establishes the conditions and requirements for workmanship-vibration testing of the Inertial Measurement Unit and PIPA Electronics Assembly, Part Number 2007203-011, hereafter referred to as the assembly.

2. APPLICABLE DOCUMENTS

2.1 EFFECTIVE ISSUES. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, Military Standards and Specifications shall be the issue in effect on the date of request for proposal or invitation to bid.

SPECIFICATIONS

APOLLO G&N

PS2007203	Procurement Specification, Product Configuration And Acceptance Test Requirements, Inertial Measurement Unit and PIPA Electronics Assembly
ATP2015497	Assembly Test Procedure, Inertial Subsystem

DRAWINGS

APOLLO G&N

2007203	Inertial Measurement Unit and PIPA Electronics Assembly

(Copies of specifications, standards, drawings, bulletins, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 CONFLICTING REQUIREMENTS. In event of a conflict between requirements, the following order of precedence shall apply. The contractor shall also notify MIT/IL APOLLO Management of the conflict.

a. The contract
b. This specification
c. Documents listed in this section

3. REQUIREMENTS

3.1 PRECAUTIONS. Normal safety precautions required during testing of precision electromechanical equipment shall be followed.

3.1.1 Heater Power. Electrical power shall be supplied to the assembly such that the temperatures of the three IRIG's shall be maintained at 135° ±5°F, and the temperature of the three PIP's shall be maintained at 130° ±5°F. Momentary disconnects of heater power to the inertial components at operating temperature are allowed for periods of up to 5 minutes.

3.1.2 Ducosyn Suspension Power. The ducosyn suspension power shall be maintained for a period of 2 hours prior to pulse torquing. If suspension power is interrupted after initial turn on and prior to completion of the 2-hour period, an additional period of suspension-on-time equivalent to the suspension interruption-time period shall be required before pulse torquing.

3.2 TEST CONDITIONS. The workmanship-vibration tests shall be performed under the following conditions:

3.2.1 Test Environment

a. Ambient Temperature: 25° ±10°C
b. Relative Humidity: 90% max
c. Barometric Pressure: 28 to 32 inches of Hg

3.2.2 Electrical Input. The simulated S/C ISS operate bus shall be 28.30±0.25 vdc.

3.2.3 Coolant Requirements. The IMU shall be provided with water-glycol coolant at a temperature of 45° ±3°F and flow rate of 33±3 lb per hour. In addition, the PSA, and PTA Coldplates shall be provided with coolant sufficient to maintain the header temperatures below 70°F.

3.2.4 Gyro Wheel Time. A record shall be kept of gyro wheel operation time.

3.3 PRIOR COMPLIANCE. Prior to performing the workmanship-vibration test on the assembly, the assembly shall have met the requirements of PS2007203, and an Inertial Subsystem, including the assembly to be tested, shall have been calibrated and tested in accordance with ATP2015497.

3.4 SUPPORT EQUIPMENT. The Power and Servo Assembly (PSA) which was tested and calibrated with the assembly in accordance with ATP2015497 (see 3.3) shall be used with the assembly during vibration testing.

3.5 TEST FAILURE

3.5.1 Failure Criteria. Failure of the assembly to perform as specified herein, failure of materials, instability of circuits, chattering of contacts, insulation breakdown or permanent change of components which would affect operational and reliability performance of the APOLLO Guidance and Navigation Equipment shall constitute failure of the assembly.

d. P_Y pulse
e. N_Y pulse
f. P_Z pulse
g. N_Z pulse

4.2.3 Failure Detect Signals. The following special condition and failure signals shall not occur before, during, or after vibration:

a. Temperature alarm signal indicating either a low or high temperature.
b. IMU failure indication.
c. Absence of both P and N pulses in the presence of an interrogate pulse.
d. Failure of the interrogate pulse.
e. Failure indication produced by the digital circuitry monitoring the P and N pulses or the interrogate pulse.

4.3 TESTS

4.3.1 Previbration and Postvibration Functional Tests. After the assembly has been mounted on the vibration machine preparatory to vibration exposure, the following tests shall be performed. After vibration along each axis, the Inertial test (4.3.1.2) and the Power Supply and Current Monitor test (4.3.1.3) shall be repeated prior to removing the assembly from its vibration machine mounting.

TABLE II

SUPPLY AND CURRENT MONITOR OUTPUTS

PARAMETER	NO. OF OUTPUTS	VALUE
800 cps 1% Supplies	2	28V ±2%
800 cps 5% Supplies (Aϕ & Optics)	2	28V ±5%
800 cps 5% Supply (Bϕ)	1	28V ±7.5%
3200 cps Supply	1	28.5V ±2%
-28 vdc Supply	1	-27.5 ±6V
120 vdc Torquing Supply	1	120V ±5%
28 vdc Torquing Supplies	3	28V ±5%
20 vdc Torquing Supply	1	20 vdc ±6%
-20 vdc Torquing Supply	1	-20 vdc ±10%
Heater Current Monitor	1	0 to 3.5 amp
Blower Current Monitor	1	0 to 1.0 amp, 1ϕ

4.3.1.1 Gimbal Cage. With the assembly in the gimbal cage mode, the gimbal angles shall be at their null positions and the 1 speed resolver outputs shall be less than 75 mv.

4.3.1.2 Inertial. With the assembly in the inertial mode, the IRIG outputs shall be less than 1.2V rms and the PIPA G/S signals shall exhibit normal moding.

4.3.1.3 Power Supply and Current Monitor. The supply and current monitor outputs shall be as specified in Table II and output signals shall be as specified in 4.2.3.

4.3.2 Vibration. With the following conditions established in the sequence indicated, the assembly shall be vibrated along each of the three orthogonal axes. The vibration shall be sinusoidal and the frequency increased at a rate of 15.0±1.5 seconds per octave. Inputs shall be 1.0g rms from 10 to 2000 cps. The Output signals shall be as specified in 4.2 during vibration.

a. The assembly, PSA, coolant cart and other test equipment connected as a unit. (The PEA cover assembly shall be replaced with tooling assembly FD 757828.).

b. All conditions and precautions specified in 3.1 and 3.2 established or verified.

c. The IMU inertial components at operating temperature and the temperature control loops in operation for at least 15 minutes.

d. The assembly energized in the inertial mode.

e. The stabilization gyros compensated for earth rate, unbalance and residual torques by analog torquing to within 5 meru and the gimbal angles equal to 0° ±1.0°.

f. The gimbal drift shall be recorded during vibration.

g. Signals recorded as specified in 4.2.

5. PREPARATION FOR DELIVERY. This section is not applicable to this specification.

6. NOTES. None.

APOLLO G&N Specification
ND1002275 A
Original Issue Date:
Release Authority: TDRR 25378
Class A Release

TEST SPECIFICATION

IMU AND PULSE TORQUE ASSEMBLY

WORKMANSHIP-VIBRATION

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA
4/5/66	A	27768	3, 7 LDL/av	WK	--

This specification consists of page 1 to 7 inclusive.

APPROVALS	A. C. METZGER NASA/MSC	MIT/IL	J. MILLER FROM TDRR	R. Mua ACSP

3. REQUIREMENTS

3.1 PRECAUTIONS. Normal safety precautions required during testing of precision electromechanical equipment shall be followed.

3.1.1 Heater Power. Electrical power shall be supplied to the assembly such that the temperatures of the three IRIG's shall be maintained at 135° ±5°F and the temperatures of the three PIP's shall be maintained at 130° ±5°F as indicated by the IMU temperature alarm. Momentary disconnects of heater power to the inertial components at operating temperature is allowed for periods of up to 5 minutes.

3.1.2 Ducosyn Suspension Power. The ducosyn suspension power shall be maintained for a period of 2 hours prior to pulse torquing. If suspension power is interrupted after initial turn on and prior to completion of a 2-hour period, an additional period of suspension on time equivalent to the suspension interruption time period shall be required before pulse torquing.

3.2 TEST CONDITIONS. The workmanship-vibration tests shall be performed under the following conditions.

3.2.1 Test Environment

a. Ambient Temperature: 25° ±10°C
b. Relative Humidity: 90% max
c. Barometric Pressure: 28 to 32 inches of Hg

3.2.2 Electrical Input. The simulated S/C IBS operate bus shall be 28.30±0.25 vdc.

3.2.3 Coolant Requirements. The IMU shall be provided with water-glycol coolant at a temperature of 45° ±3°F and flow rate of 33±3 lb per hour. In addition, the PSA, and PTA Coldplates shall be provided with coolant sufficient to maintain the header temperature below 70°F.

3.2.4 Gyro Wheel Time. A record of gyro wheel operation time shall be maintained.

3.3 PRIOR COMPLIANCE. Prior to performing the workmanship-vibration test on the assembly, an Inertial Subsystem including the assembly to be tested, shall have been calibrated and tested in accordance with ATP6015497 or PS6007001.

3.4 SUPPORT EQUIPMENT. The PSA which was tested and calibrated with the assembly in accordance with ATP6015497 shall be used with the assembly during vibration testing.

TABLE II

POWER SUPPLY AND CURRENT MONITOR OUTPUTS

PARAMETER	NO. OF OUTPUTS	VALUE
800 cps 1% supplies	1	28V±2%
800 cps 5% A$ supply	1	28V±5%
800 cps 5% B$ supply	1	28V±7.5%
3200 cps supply	1	28.8V±2%
-28 vdc supply	1	-27.0±6V
120 vdc torquing supply	1	120V±5%
28 vdc torquing supply	3	28 vdc ±5%
Heater current monitor	1	0 to 3.8 amp
Blower current monitor	1	0 to 1.0 amps total
[illegible]	1	0 to [illegible] amp
[illegible]	1	[illegible]

4.3.2 Vibration. With the following conditions established in the sequence listed, the assembly shall be vibrated along each of the orthogonal axes. The vibration shall be sinusoidal and the frequency increased at a rate of 15.0±1.5 seconds per octave. Inputs shall be 1.0g rms from 10 to 2000 cps. The output signals shall be as specified in 4.2 during vibration.

a. The assembly, PSA, coolant cart and other test equipment connected as a unit. (The PTA cover assembly shall be replaced with tooling assembly FD757759).

b. All conditions and precautions specified in 3.1 and 3.2 established or verified.

c. The IMU inertial components at operating temperature and the temperature control loops in operation for at least 15 minutes.

d. The assembly energized in the inertial mode.

e. The stabilization gyros compensated for earth rate, unbalance and residual torques by analog torquing to within 5 meru and the gimbal angles equal to 0.0° ±1.0° .

f. The gimbal drift shall be recorded during vibration.

g. Signals recorded as specified in 4.2. [illegible] is not applicable to this specification.

5. PREPARATION FOR DELIVERY. This section is not applicable to this specification.

6. NOTES. None.

RM:jls

APOLLO G&N Specification
ND1002275 B
Original Issue Date:
Release Authority: TDRR 25378
Class A Release

TEST SPECIFICATION

IMU AND PULSE TORQUE ASSEMBLY

WORKMANSHIP-VIBRATION

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals MIT	Approvals NASA
(M) 4/5/66	A	27768	3, 7 WK/ar	WK	--
5/17/66	B	28902	3 JF/AC	MGM	--

This specification consists of page 1 to 7 inclusive.

APPROVALS	A. C. METZGER NASA/MSC	CJB	MIT/IL	J. MILLER FROM TDRR WK	J. Hackbarth R. Mura C. Goodman ACSP

APOLLO G&N Specification
ND1002275
Original Issue Date:
Release Authority: TDRR 25378
Class A Release

TEST SPECIFICATION

IMU AND PULSE TORQUE ASSEMBLY

WORKMANSHIP-VIBRATION

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA

This specification consists of page 1 to 7 inclusive.

APPROVALS	A. C. METZGER NASA/MSC	AJB	MIT/IL	J. MILLER FROM TDRR	R. Mina ACSP

1. SCOPE

1.1 PURPOSE. This specification establishes the conditions and requirements for workmanship-vibration testing of the Inertial Measurement Unit and Pulse Torque Assembly, Part Number 6007001-011, hereafter referred to as the assembly.

2. APPLICABLE DOCUMENTS

2.1 EFFECTIVE ISSUES. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, Military Standards and Specifications shall be the issue in effect on the date of request for proposal or invitation to bid.

SPECIFICATIONS

APOLLO G&N

FS6007001	Procurement Specification for the Inertial Measurement Unit and Pulse Torque Assembly
ATP6015497	Assembly Test Procedure for Inertial Subsystem

DRAWINGS

APOLLO G&N

6007001	Inertial Measurement Unit and Pulse Torque Assembly

(Copies of specifications, standards, drawings, bulletins, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 CONFLICTING REQUIREMENTS. In the event of a conflict between requirements, the following order of precedence shall apply. The contractor shall also notify MIT/IL APOLLO Management of the conflict.

a. The contract
b. This specification
c. Documents listed in this section.

3. REQUIREMENTS

3.1 PRECAUTIONS. - Normal safety precautions required during testing of precision electro-mechanical equipment shall be followed.

3.1.1 Heater Power. Electrical power shall be supplied to the assembly such that the temperatures of the three IRIG's shall be maintained at 135° ±5°F and the temperatures of the three PIP's shall be maintained at 130° ±5°F as indicated by the IMU temperature alarm. Momentary disconnects of heater power to the inertial components at operating temperature is allowed for periods of up to 5 minutes.

3.1.2 Ducosyn Suspension Power. The ducosyn suspension power shall be maintained for a period of 2 hours prior to pulse torquing. If suspension power is interrupted after initial turn on and prior to completion of a 2-hour period, an additional period of suspension on time equivalent to the suspension interruption time period shall be required before pulse torquing.

3.2 TEST CONDITIONS. The workmanship-vibration tests shall be performed under the following conditions.

3.2.1 Test Environment

a. Ambient Temperature: 25° ±10°C
b. Relative Humidity: 90% max
c. Barometric Pressure: 28 to 32 inches of Hg

3.2.2 Electrical Input. The simulated S/C IBS operate bus shall be 28.20±0.25 vdc±0.25 vdc.

3.2.3 Coolant Requirements. The IMU shall be provided with water-glycol coolant at a temperature of 45° ±3°F and flow rate of 33±3 lb per hour. In addition, the PSA, and PTA Coldplates shall be provided with coolant sufficient to maintain the heater temperatures below 70°F.

3.2.4 Gyro Wheel Time. A record of gyro wheel operation time shall be maintained.

3.3 PRIOR COMPLIANCE. Prior to performing the workmanship-vibration test on the assembly, the assembly shall have met the requirements of PS6007001; and an Inertial Subsystem, including the assembly to be tested, shall have been calibrated and tested in accordance with ATP6015497.

3.4 SUPPORT EQUIPMENT. The PSA which was tested and calibrated with the assembly in accordance with ATP6015497 shall be used with the assembly during vibration testing.

TABLE II

POWER SUPPLY AND CURRENT MONITOR OUTPUTS

PARAMETER	NO. OF OUTPUTS	VALUE
800 cps 1% supplies	1	28V±2%
800 cps 5% A∅ supply	1	28V±5%
800 cps 5% B∅ supply	1	28V±7.5%
3200 cps supply	1	28.5V±2%
-28 vdc supply	1	-27.0±3V
120 vdc torquing supply	1	120V±5%
28 vdc torquing supply	3	28 vdc ±5%
Heater current monitor	1	0 to 3.5 amp
Blower current monitor	1	0 to 1.0 amp/phase
Heater current monitor	1	0 to 3.5 amp
Blower current monitor	1	0 to 1.0 amp/phase

4.3.2 Vibration. With the following conditions established in the sequence listed, the assembly shall be vibrated along each of the orthogonal axes. The vibration shall be sinusoidal and the frequency increased at a rate of 15.0±1.5 seconds per octave. Inputs shall be 1.0g rms from 10 to 2000 cps. The output signals shall be as specified in 4.2 during vibration.

a. The assembly, PSA, coolant cart and other test equipment connected as a unit. (The PTA Cover assembly shall be replaced with tooling assembly FD757759).

b. All conditions and precautions specified in 3.1 and 3.2 established or verified.

c. The IMU inertial components at operating temperature and the temperature control loops in operation for at least 15 minutes.

d. The assembly energized in the inertial mode.

e. The stabilization gyros compensated for earth rate, unbalance and residual torques by analog torquing to within 5 meru and the gimbal angles equal to 0.0° ±1.0° .

f. The gimbal drift shall be recorded during vibration.

g. Signals recorded as specified in 4.3 .

5. PREPARATION FOR DELIVERY. This section is not applicable to this specification.

6. NOTES. None.

RM:jlb

APOLLO G&N Specification
ND 1002277
Original Issue Date:
Release Authority: TDRR 22374
Class A Release 9/8/65

PROCESS SPECIFICATION

FOR

APPLICATION OF LIGHT DIFFUSING COATINGS

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA

This specification consists of page 1 to 5 inclusive.

APPROVALS	NASA/MSC	MIT/IL	
			KIC

NOT REQUIRED PER LETTER
NASA PP7-65-612

3.2.3 Mechanical paint mixer, Red Devil Paint Conditioner.

3.2.4 Suitable fixtures, trays, racks, etc. for proper handling of the work load.

3.2.5 Zahn Cup No. 2.

3.2.6 Sable hair brush for touch-up purposes only.

3.2.7 Equipment to measure the thickness of the coating such as Dermitron, Magne-Gage or Dermascope.

3.3 Storage stability

3.3.1 Each component shall have a shelf life of at least 12 months when stored in closed containers at a maximum ambient temperature of 95°F (35°C).

3.3.2 Any material which has exceeded the expiration date marked on the container by the manufacturer shall not be used.

3.4 Preparation of coating material

3.4.1 Thoroughly agitate the base resin, component No. 1 of 1012543, in its original container using a mechanical paint mixer or shaker.

3.4.2 Add one volume of the converter-catalyst, component No. 2 of 1012543 to three volumes of the base resin, component No. 1 of 1012543, and mix thoroughly on a mechanical paint mixer or shaker.

3.4.2.1 The visocity of the mixed coating material shall be a maximum of 34 seconds measured with a No. 2 Zahn Cup.

3.4.3 If siphon spray equipment is used, reduce (thin) the mixed coating material up to 10% by volume with Xylene conforming to TT-X-916.

3.4.3.1 The viscosity of the Xylene reduced (thinned) mixed coating shall be a maximum of 24 seconds measured with a No. 2 Zahn Cup.

3.4.4 If the mixed-coating material (3.4.2) or the reduced (thinned) mixed coating material (3.4.3) fails to meet the viscosity requirements indicated in 3.4.2.1 and 3.4.3.1, the prepared coating material shall not be used and shall be discarded. In addition, the containers and the contents from which the coating material was prepared shall also be discarded.

APOLLO G&N Specification
ND1002279
Original Issue Date: 4/14/65
Release Authority: TDRR 22449
Class A Release

PROCESS SPECIFICATION

APPLICATION OF EPOXY PAINT

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA

This specification consists of page 1 to 5 inclusive.

APPROVALS	NASA/MSC	MIT/IL	ACSP
		A M Laudeman W H Kepler 4/14/65	W. Sutherland L. Kroll R. Mina

NOT REQUIRED PER LETTER
NASA PP7-65-612

1. SCOPE

1.1 PURPOSE. This specification establishes the process requirements for the application of epoxy paint.

1.2 CLASSIFICATION. The requirements for the process covered by this specification shall be designated as ND1002279-001. This shall include all requirements specified in Sections 1 through 6 of this specification.

2. APPLICABLE DOCUMENTS

2.1 EFFECTIVE ISSUES. The following documents of the issue in effect on the date of invitation for bids form a part of this specification to the extent specified herein.

SPECIFICATIONS

Federal

TT-X-916	Xylene (For use in organic coatings)

Military

MIL-T-19588	Toluene-Methyl Isobutyl Ketone Mixture

DRAWINGS

APOLLO G&N

1008809	Paint, Epoxy
1010992	Primer Coating, Epoxy Polyamide Chemical and Solvent Resistant

PUBLICATIONS

NASA

NPC 200-2	NASA Quality Publication, Quality Program for Space System Contractors

3. REQUIREMENTS

3.1 MATERIAL. The coating system covered by this process shall consist of a two component epoxy primer conforming to the requirements specified on Drawing 1010992, and a two component epoxy paint conforming to the requirements specified on Drawing 1008809.

3.2 RESTRICTIONS. Unless otherwise specified on the applicable drawing, the finish shall be omitted from surfaces having a total dimensional tolerance of less than 0.001 inch, from inside cup or box shaped parts, and from all tapped and pin holes.

3.3 PRETREATMENT. Prior to the application of the coating, the parts to be finished shall be treated as specified on the applicable drawing. When no pretreatment is specified, the parts shall be pretreated as follows with the exception that nonmetallic parts shall receive no pretreatment other than cleaning.

3.3.1 Cleaning. Where surface contamination is inherent in the fabrication of the part or assembly, the contaminants shall be removed with a solvent or cleaning agent which is compatible with the material to be coated. Care shall be exercised in the handling of pretreated parts to prevent surface contamination due to fingerprints, oils, greases, release agents, moisture, dust or other foreign material which would affect the adherence or appearance of the coating.

3.3.2 Surface Roughening. The surfaces of ferrous parts (including corrosion resistant steel) and nickel plated parts shall be vapor blasted after cleaning to produce a uniform matte appearance. The surfaces of the parts shall be given a water spray rinse to remove all traces of blast grit, then dried to remove moisture.

3.4 PRIMING. Unless otherwise specified, all surfaces to be finished shall receive a primer coat prior to the application of a top coat of epoxy paint.

3.4.1 Preparation. Prior to blending the two components together, the components shall be individually stirred and have a temperature of 65° to 95°F. After the individual stirring, equal volumes of the components shall be blended together to form the primer. When thinning to a spray consistency is desired, a thinner conforming to the requirements of Specification MIL-T-19588 or a thinner consisting of equal volumes of methyl-isobutyl-ketone and toluol shall be mixed into the blended primer. The primer shall then be allowed to stand for a minimum of 1 hour at room temperature before use.

3.4.2 Application. The primer shall be used within 8 hours after mixing and shall be applied in one wet pass to a dry film thickness of 0.3 to 0.7 mil.

3.4.3 Curing. Unless otherwise specified, the primer shall be allowed to air dry for a minimum of 1 hour before applying the top coat of epoxy paint.

3.5 PAINTING

3.5.1 Preparation. Prior to blending the two components together, the components shall be individually stirred. After stirring, the two components shall be blended together in the ratio

of 1 part by volume of part B (catalyst) to 2 parts by volume of part A (resin). When thinning to a spray consistency is desired, xylene, which conforms to the requirements of Specification TT-X-916, shall be mixed into the blended paint. The paint shall then be allowed to stand at room temperature for a minimum of 1 hour before use.

3.5.2 Application. The mixed paint shall be used within 8 hours after mixing and shall be applied over the primed surfaces to a dry film thickness of 1 to 1.5 mil, unless otherwise specified.

3.5.3 Curing. The applied film of paint shall be allowed to air dry a minimum of 30 minutes before applying a force cure (a cure at a temperature other than room temperature). The force cure schedule shall be in accordance with Table I unless otherwise specified on the applicable drawing, or if the underlying substrate is a nonmetallic material.

3.5.3.1 Nonmetallic Materials. The force cure of nonmetallic materials shall employ a temperature schedule which is compatible with the underlaying substrate and may vary from the cure schedule specified in Table I as long as a satisfactory finish is obtained.

TABLE I

CURING SCHEDULE

CURE TEMPERATURE (°F)	TIME (Min)
150 ± 5	20 minutes
140 ± 5	35 minutes
130 ± 5	60 minutes
120 ± 5	120 minutes
Room Temp	8 hours

3.6 CURED FILM PROPERTIES. The properties of the cured paint shall conform to the requirements of Drawing 1008809 when tested as specified therein.

3.7 WORKMANSHIP. The primer and paint shall be smooth and uniform in appearance, free from sags, voids or other irregularities which would not reflect a good finish. Irregularities in the applied film, such as dirt, lint, small runs, pits and metal defects not completely hidden by the applied paint, shall be eliminated by using proper equipment, processes and application techniques.

4. QUALITY ASSURANCE PROVISIONS

4.1 PROCESS AND QUALITY CONTROL. The processor shall maintain sufficient process and quality control to assure that the requirements of this specification are met in accordance with the provisions of Publication NPC 200-2.

5. PREPARATION FOR DELIVERY. This section is not applicable to this specification.

6. NOTES

6.1 INTENDED USE. This process is intended for use in the application of epoxy paint on the APOLLO Guidance and Control Ground Support and Airborne Equipment.

WS:lv

APOLLO G&N Specification
ND 1002285
Original Issue Date:
Release Authority: TDRR 23614
Class A **Release**

PROCESS REQUIREMENTS FOR CONTROL AND INSPECTION OF ROPE MEMORY ASSEMBLIES

Record of Revisions

	Date	Revision Letter	TDRR No.	Pages Revised	Approvals MIT	Approvals NASA
(M)	1/25/66	A	25533	3, 5		

This specification consists of pages 1 to 5 inclusive.

APPROVALS	A. C. METZGER NASA/MSC	10/28/65	R C Hall 11/4/65 MIT/IL	W Cooper 2 Nov 65	A. Franco 10 Oct 1965 W Dayton 11 Oct 1965 W Fund 11 Oct RAY

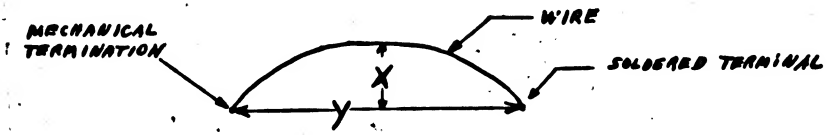


FIGURE 1
STRESS RELEASE LOOP- $\frac{X}{Y} \geq \frac{1}{6}$

3.3 Wire Routing. The following requirements shall apply to wire routing of inhibit and sense wires.

3.3.1 Crossing Core Openings. As little slack as possible shall be maintained without the inhibit wires or sense wires crossing any core openings.

3.3.2 Total Wires. The maximum number of inhibit and sense wires, including incorrect wires, shall not exceed that number which would cause a mechanical interference thru the core openings i.e. blocking of the core opening which would prevent threading of any more wire thru the core.

3.3.3 Incorrect or Defective Wires. After threading, incorrect or defective wires shall not be removed. The cut or broken ends of incorrect or defective wires shall be coated with clear insulating compound per SCD 1006303.

3.3.4 Examination of Wire. After the threading of every sixteen (16) wires, the wires shall be examined for the following.

3.3.4.1 Insulation. Insulation shall be intact, except at the solder joints, when examined under 10X magnification. Nicks, cuts, or scratches which do not expose bare wire shall not be cause for rejection. The cut ends of incorrect or defective wires shall be insulated per par 3.3.3.

3.4 Electrical. The following electrical requirements shall apply.

3.4.1 Functional Electrical Tests. Functional electrical tests shall be performed at the completion of the following manufacturing operations:

A. Inhibit wiring
B. Sense wiring
C. Core holder potting
D. Final assembly
E. Final potting

3.4.2 Continuity. Continuity tests shall be performed at the completion of sense wiring and at the completion of core holder potting. Inhibit wire runs shall exhibit 1.5 to 4.5 ohms and sense wire runs 3.5 to 12 ohms when measured with an appropriate ohmeter or Robotester Model LA 30303 or equivalent.

3.4.3 Insulation Resistance. Insulation resistance tests shall be performed at the completion of sense wiring and at the completion of core holder potting. The insulation resistance between any one wire and all other wires shall be not less than 10 megohms at 50 volts when measured with an appropriate ohmeter or equivalent.

4. QUALITY ASSURANCE PROVISIONS

4.1 Visual Examination. Visual examination shall be performed on 100% of production on the soldering (par 3.2) and wire routing (par 3.3) requirements of this specification.

4.2 Examination Testing. Examination testing shall be conducted on 100 percent of production on the electrical requirements (par 3.4) of this specification.

PREPARATION FOR DELIVERY

5.1 Preservation & Packaging. The rope memory module assembly shall be preserved and packaged in accordance with ND 1002214.

6. NOTES

6.1 Intended Use. The rope memory assemblies (2003053) are intended for use in the APOLLO Guidance Computer.

(REV A)

APOLLO G&N Specification
ND 1002285
Original Issue Date:
Release Authority: TDRR 23614
Class A **Release**

PROCESS REQUIREMENTS FOR CONTROL AND INSPECTION OF ROPE MEMORY ASSEMBLIES

Record of Revisions

	Date	Revision Letter	TDRR No.	Pages Revised	Approvals MIT	Approvals NASA
M	1/25/66	A	25533	3, 5		
M	3-15-66	B	27108	5		

This specification consists of pages 1 to 5 inclusive.

APPROVALS	A. C. METZGER NASA/MSC	10/28/65	R C Hall 11/9/65 MIT/IL	W Cupler 2 Nov 65	A Franceschi 15 Oct 1965 W Dayton 15 Oct 1965 W Fund 11 Oct RAY

3.4 Electrical. The following electrical requirements shall apply.

3.4.1 Functional Electrical Tests. Functional electrical tests shall be performed at the completion of the following manufacturing operations:

A. Inhibit wiring
B. Sense wiring
C. Core holder potting
D. Final assembly
E. Final potting

3.4.2 Continuity. Continuity tests shall be performed at the completion of sense wiring and at the completion of core holder potting. Inhibit wire runs shall exhibit 1.5 to 4.5 ohms and sense wire runs 3.5 to 12 ohms when measured with an appropriate ohmeter or Robotester Model LA 30303 or equivalent.

3.4.3 Insulation Resistance. Insulation resistance tests shall be performed at the completion of sense wiring and at the completion of core holder potting. The insulation resistance between any one wire and all other wires shall be not less than 10 megohms at 50 or 100 volts when measured with an appropriate ohmeter or equivalent.

4. QUALITY ASSURANCE PROVISIONS

4.1 Visual Examination. Visual examination shall be performed on 100% of production on the soldering (par 3.2) and wire routing (par 3.3) requirements of this specification.

4.2 Examination Testing. Examination testing shall be conducted on 100 percent of production on the electrical requirements (par 3.4) of this specification.

PREPARATION FOR DELIVERY

5.1 Preservation & Packaging. The rope memory module assembly shall be preserved and packaged in accordance with ND 1002214.

6. NOTES

6.1 Intended Use. The rope memory assemblies (2003053) are intended for use in the APOLLO Guidance Computer.

(REV B)

APOLLO G&N Specification
ND 1002285
Original Issue Date:
Release Authority: TDRR 23614
Class A **Release**

PROCESS REQUIREMENTS

FOR

CONTROL AND INSPECTION OF

ROPE MEMORY ASSEMBLIES

Record of Revisions

	Date	Revision Letter	TDRR No.	Pages Revised	Approvals MIT	Approvals NASA
M	1/25/66	A	25533	3, 5		
M	3-15-66	B	27108	5		
M	5/17/66	C	28878	1, 5		

This specification consists of pages 1 to 5 inclusive.

APPROVALS	A. C. METZGER NASA/MSC	10/28/65	R C Hall 11/9/65 MIT/IL	W Tupper 2 Nov 65	15 Oct 1965

3.4 Electrical. The following electrical requirements shall apply.

3.4.1 Functional Electrical Tests. Functional electrical tests shall be performed at the completion of the following manufacturing operations:

A. Inhibit wiring
B. Sense wiring
C. Core holder potting
D. Final assembly
E. Final potting

3.4.2 Continuity. Continuity tests shall be performed at the completion of sense wiring and at the completion of core holder potting. Inhibit wire runs shall exhibit 1.5 to 4.5 ohms except for wire numbers 207, 211, 212, and 213 which shall exhibit 3 to 5.5 ohms, and sense wire runs 3.5 to 12 ohms when measured with an appropriate ohmeter or Robotester Model LA 30303 or equivalent.

3.4.3 Insulation Resistance. Insulation resistance tests shall be performed at the completion of sense wiring and at the completion of core holder potting. The insulation resistance between any one wire and all other wires shall be not less than 10 megohms at 50 or 100 volts when measured with a DITMCO 610 or Robotester or equivalent.

4. QUALITY ASSURANCE PROVISIONS

4.1 Visual Examination. Visual examination shall be performed on 100% of production on the soldering (par 3.2) and wire routing (par 3.3) requirements of this specification.

4.2 Examination Testing. Examination testing shall be conducted on 100 percent of production on the electrical requirements (par 3.4) of this specification.

PREPARATION FOR DELIVERY

5.1 Preservation & Packaging. The rope memory module assembly shall be preserved and packaged in accordance with ND 1002214.

6. NOTES

6.1 Intended Use. The rope memory assemblies (2003053) are intended for use in the APOLLO Guidance Computer.

APOLLO G&N Specification
ND 1002285
Original Issue Date:
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Class A **Release**

PROCESS REQUIREMENTS FOR CONTROL AND INSPECTION OF ROPE MEMORY ASSEMBLIES

Record of Revisions

	Date	Revision Letter	TDRR No.	Pages Revised	Approvals MIT	Approvals NASA
M	1/25/66	A	25533	3, 5		
M	8-15-66	B	27108	5		
M	5/17/66	C	28878	1, 5		
M	9/22/66	D	31136	1, 2, 3, 5		

This specification consists of pages 1 to 5 inclusive.

APPROVALS	A. C. METZGER NASA/MSC	10/28/65	E C Hall 11/9/65 MIT/IL	W Tuttle 2 Nov 65

1

3.4 Electrical. The following electrical requirements shall apply.

3.4.1 Functional Electrical Tests. Functional electrical tests shall be performed at the completion of the following manufacturing operations:

A. Inhibit wiring
B. Sense wiring
C. Core holder potting
D. Final assembly
E. Final potting

3.4.2 Continuity. Continuity tests shall be performed at the completion of sense wiring and at the completion of core holder potting. Inhibit wire runs shall exhibit 1.5 to 4.5 ohms except for wire numbers 207, 211, 212, and 213 which shall exhibit 3 to 5.5 ohms, and sense wire runs 3.5 to 12 ohms when measured with an appropriate ohmeter or Robotester Model LA 30303 or equivalent.

3.4.3 Insulation Resistance. Insulation resistance tests shall be performed at the completion of sense wiring and at the completion of core holder potting. The insulation resistance between any one wire and all other wires shall be not less than 10 megohms at 50 or 100 volts when measured with a DITMCO 610 or Robotester or equivalent.

4. QUALITY ASSURANCE PROVISIONS

4.1 Visual Examination. Visual examination shall be performed on 100% of production on the soldering (par 3.2) and wire routing (par 3.3) requirements of this specification.

4.2 Examination Testing. Examination testing shall be conducted on 100 percent of production on the electrical requirements (par 3.4) of this specification.

PREPARATION FOR DELIVERY

5.1 Preservation & Packaging. The rope memory module assembly shall be preserved and packaged in accordance with ND 1002214.

6. NOTES

6.1 Intended Use. The rope memory assemblies (2003053) & (2003972) are intended for use in the APOLLO Guidance Computer.

APOLLO G&N Specification
ND 1002285
Original Issue Date:
Release Authority: TDRR 23614
Class A **Release**

PROCESS REQUIREMENTS FOR CONTROL AND INSPECTION OF ROPE MEMORY ASSEMBLIES

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA

This specification consists of pages 1 to 5 inclusive.

APPROVALS	A. C. METZGER NASA/MSC	10/28/65	E C Hall 11/4/65 MIT/IL	W Cooper 2 Nov 65	15 Oct 1965 W Dayton 15 Oct 1965 RAY

PROCESS REQUIREMENTS

FOR

CONTROL AND INSPECTION OF

ROPE MEMORY ASSEMBLIES

1. SCOPE

1.1 Scope. This document establishes the process requirements for control and inspection in the fabrication of rope memory assemblies (Dwg 2003053) to be used in the APOLLO Guidance Computer.

2. APPLICABLE DOCUMENTS

2.1 The following documents form a part of this specification to the extent specified herein.

DRAWINGS

NASA -

2003053	Fixed Memory Module Assembly
SCD 1006303	Insulating Compound, Electrical, Quick Drying

SPECIFICATIONS

NASA -

ND 1002071	Soldering, General
ND 1002214	Specification for preservation and Packaging of AGE Assemblies and Sub-Assemblies

3. REQUIREMENTS

3.1 Unless otherwise specified, a preproduction sample shall meet all the requirements of this specification.

3.2 Soldering. Soldering shall be in accordance with ND 1002071 except stripping of the leads shall be by abrasion and shall be limited to the use of fiberglass. Stripped leads to be soldered shall be clean, and 2 to 4 turns of bare wire plus 3/4 to 1 1/2 turns of insulated wire shall be securely wrapped. In addition, a stress release loop shall be formed per Figure 1.

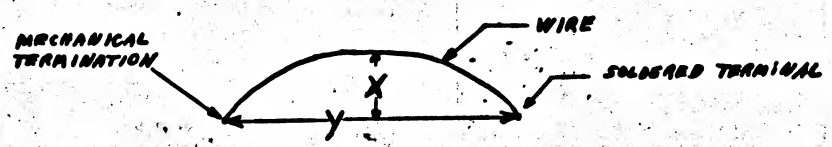


FIGURE 1
STRESS RELEASE LOOP- $\frac{X}{Y} \geq \frac{1}{6}$

3.3 Wire Routing. The following requirements shall apply to wire routing of inhibit and sense wires.

3.3.1 Crossing Core Openings. As little slack as possible shall be maintained without the inhibit wires or sense wires crossing any core openings.

3.3.2 Total Wires. The maximum number of inhibit and sense wires, including incorrect wires, shall not exceed that number which would cause a mechanical interference thru the core openings i.e. blocking of the core opening which would prevent threading of any more wire thru the core.

3.3.3 Incorrect or Defective Wires. After threading, incorrect or defective wires shall not be removed. The cut or broken ends of incorrect or defective wires shall be coated with clear insulating compound per SCD 1006303.

3.3.4 Examination of Wire. After the threading of every eight (8) wires, the wires shall be examined for the following.

3.3.4.1 Insulation. Insulation shall be intact, except at the solder joints, when examined under 10X magnification. Nicks, cuts, or scratches which do not expose bare wire shall not be cause for rejection. The cut ends of incorrect or defective wires shall be insulated per par 3.3.3.

3.4 Electrical. The following electrical requirements shall apply.

3.4.1 Functional Electrical Tests. Functional electrical tests shall be performed at the completion of the following manufacturing operations:

A. Inhibit wiring
B. Sense wiring
C. Core holder potting
D. Final assembly
E. Final potting

3.4.2 Continuity. Continuity tests shall be performed at the completion of sense wiring and at the completion of core holder potting. Inhibit wire runs shall exhibit 2 to 5 ohms and sense wire runs 2 to 10 ohms when measured with an appropriate ohmeter or Robotester Model IA 30303 or equivalent.

3.4.3 Insulation Resistance. Insulation resistance tests shall be performed at the completion of sense wiring and at the completion of core holder potting. The insulation resistance between any one wire and all other wires shall be not less than 5 megohms at 100 volts when measured with an appropriate ohmeter or equivalent.

4. QUALITY ASSURANCE PROVISIONS

4.1 Visual Examination. Visual examination shall be performed on 100% of production on the soldering (par 3.2) and wire routing (par 3.3) requirements of this specification.

4.2 Examination Testing. Examination testing shall be conducted on 100 percent of production on the electrical requirements (par 3.4) of this specification.

PREPARATION FOR DELIVERY

5.1 Preservation & Packaging. The rope memory module assembly shall be preserved and packaged in accordance with ND 1002214.

6. NOTES

6.1 Intended Use. The rope memory assemblies (2003053) are intended for use in the APOLLO Guidance Computer.

APOLLO G&N Specification
ND 1002288 –
Original Issue Date: 2/23/66
Release Authority: TDRR 26617
Class A Release

PROCESS SPECIFICATION

FOR

MOLDING WITH POLYURETHANE FOAM

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA

This specification consists of page 1 to 3 inclusive.

APPROVALS	A. C. METZGER NASA/MSC	MIT/IL	N Brunelle Eng 2-9-66 F Callahan QA 2-9-66 B Haussmann PA 2-9-66 KIC

3.7.3 Prepare and mix a sufficient amount of foam ingredients (resin and hardner) per paragraph 3.5, to fill the mold cavity.

3.7.4 Immediately pour or inject the mixed foam into the mold cavity preheated to 95°F (35°C).

3.7.5 Cure the foam by one of the following methods:

3.7.5.1 Allow the foam to cure undisturbed in its mold for a minimum of 16 hours at room temperature.

3.7.5.2 Allow the foam to cure undisturbed in its mold for a minimum of one hour at room temperature, followed by an oven cure at 180° ± 20°F for a minimum of two (2) hours. Allow oven-cured parts to cool to room temperature, before removing from mold.

4. QUALITY ASSURANCE PROVISIONS

4.2 Inspection

4.1.1 All parts fabricated per this specification shall be 100% inspected with the unaided eye.

4.1.2 The color of the cured foam shall be in accordance with the applicable SCD. The skin surfaces shall be lusterless to semi-gloss.

4.1.3 The parts shall be uniform in texture and mechanical properties. They shall be free from lumps and coarse particles. There shall be no accumulation of unblown or uncured resin nor any inclusion of foreign matter. The parts shall be free from defects that might affect serviceability.

4.1.4 Parts shall meet all dimensional requirements specified on the applicable detail drawing when measured in the mold or in a restrained position.

5. PREPARATION FOR DELIVERY

None

6. NOTES

6.1 Shelf Life

6.1.1 The open container shelf life of the materials can be extended by purging the materials with anhydrous nitrogen prior to being re-sealed.

APOLLO G&N Specification
ND1002289 A
Original Issue Date: 4 JAN 1966
Release Authority: TDRR 25004
Class A Release
CODE IDENT. NO. 99974

PROCESS SPECIFICATION

LOW EMISSIVITY COATING

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA
6/1/66	A	29194	2, 4, 5 CD6/AC	MGM	----

This specification consists of page 1 to 6 inclusive.

APPROVALS	C. METZGER NASA/MSC	A Laurmann 12/28/65 MIT/IL	V. Pagliaro 12/28/65 W. Sutherland ACSP

1. SCOPE

1.1 PURPOSE. This specification describes the process for the formulation and application of a low emissivity coating to anodized aluminum and magnesium.

1.2 CLASSIFICATION. The requirements for the process covered by this specification shall be designated as ND1002289-001. This shall include all requirements specified in Sections 1 through 6 of this specification.

2. APPLICABLE DOCUMENTS

2.1 EFFECTIVE ISSUES. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, Military Standards and Specifications shall be the issue in effect on the date of request for proposal or invitation to bid.

SPECIFICATIONS

Federal

BB-F-671	Freon Gas, Compressed (Chlorofluoro Hydro-carbons)
TT-M-261	Methyl Ethyl Ketone
TT-P-320	Pigment, Aluminum, for Paint
TT-T-548	Toluene, Technical

DRAWINGS

NASA

1010657	Epoxy Resin (Clear)
1010686	Catalyst
1010992	Epoxy Primer Coating

PUBLICATIONS

NASA

NPC 200-2	NASA Quality Publication, Quality Program for Space System Contractors

3.4 APPLICATION. The following technique shall be used to obtain the desired coating:

a. The method of application shall be by spray only, as this system does not lend itself to brushing.

b. Application pressure shall be 40±5 psi. Excessive spray pressure results in balling up of the aluminum flake and prevents leafing.

c. A minimum dry film thickness of 0.0015" is required to obtain the required emissivity.

d. Continuous agitation during spray is required to keep the pigment well dispersed.

e. The finish shall be applied in multiple coats, allowing 20 minutes minimum flash-off time between coats.

f. Care shall be exercised during and after the application of the finish to prevent dirt, dust, and other particles from contaminating the surface. This finish is highly susceptible to fingerprinting, smudging, etc., and finished parts shall therefore be handled using finger cots and other protective handling devices.

3.5 CURE. The applied coating shall be air dried for 30 minutes minimum. To ensure that optimum properties of the finish are obtained, the air-dried coating shall be followed by a force cure of 2 hours minimum at 150°F.

3.6 WORKMANSHIP. The coating shall be smooth, bright and uniform in appearance, free from sags, voids or other irregularities which would affect the emissivity. The coating shall show no signs of balling or delamination which would result in a rough matte finish rather than a bright shiny one. The coating shall be free of included dust or other particles which would affect the emissivity.

APOLLO G&N Specification
ND1002289 B
Original Issue Date: 4 JAN 1966
Release Authority: TDRR 25006
Class A Release
CODE IDENT. NO. 99974

PROCESS SPECIFICATION

LOW EMISSIVITY COATING

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA
(1) 6/1/66	A	29194	2, 4, 5 CG/AC	MGM	----
7/1/66	B	29904	5 CG/AC	MGM	

This specification consists of page 1 to 6 inclusive.

APPROVALS	C. MELZGER NASA/MSC	A Laurmann 12/29/65	MIT/IL	V. Pagliaro	J. Sutherland ACSP

3.4 APPLICATION. The following technique shall be used to obtain the desired coating:

a. The method of application shall be by spray only, as this system does not lend itself to brushing.

b. Application pressure shall be 40±5 psi. Excessive spray pressure results in balling up of the aluminum flake and prevents leafing.

c. A minimum dry film thickness of 0.0015" is required to obtain the required emissivity.

d. Continuous agitation during spray is required to keep the pigment well dispersed.

e. The finish shall be applied in multiple coats, allowing 20 minutes minimum flash-off time between coats.

f. Care shall be exercised during and after the application of the finish to prevent dirt, dust, and other particles from contaminating the surface. This finish is highly susceptible to fingerprinting, smudging, etc., and finished parts shall therefore be handled using finger cots and other protective handling devices.

3.5 CURE. The applied coating shall be air dried for 30 minutes minimum. To ensure that optimum properties of the finish are obtained, the air-dried coating shall be followed by a force cure of 2 hours minimum at 150°F.

3.6 TOUCH-UP. Damaged or bare areas shall be touched-up by spray or other suitable means of application in accordance with all requirements of this specification.

3.7 WORKMANSHIP. The coating shall be smooth, bright and uniform in appearance, free from sags, voids or other irregularities which would affect the emissivity. The coating shall show no signs of balling or delamination which would result in a rough matte finish rather than a bright shiny one. The coating shall be free of included dust or other particles which would affect the emissivity.

APOLLO G&N Specification
ND1002289 C
Original Issue Date: 4 JAN 1966
Release Authority: TDRR 25004
Class A Release
CODE IDENT. NO. 99974

PROCESS SPECIFICATION

LOW EMISSIVITY COATING

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals MIT	Approvals NASA
(N) 6/1/66	A	29194	2, 4, 5 RDG/AC	MGM	----
(M) 7/1/66	B	29904	5 RDG/AC	MGM	
9/9/66	C	31141	2, 3, 5, 6 Was 6 pages now 7 RDG/AC	EA	ACM

This specification consists of page 1 to 7 inclusive.

APPROVALS	A. C. METZGER NASA/MSC	A Levanon 12/28/65	MIT/IL	V. Pagliaro R. Sutherland ACSP

d. Parts shall be cured in accordance with the following cure schedule:

(1) The area repaired shall be cured 30 hrs min at 135° ± 5°F.

3.7 WORKMANSHIP. The coating shall be smooth, bright and uniform in appearance, free from sags, voids or other irregularities which would affect the emissivity. The coating shall show no signs of balling or delamination which would result in a rough matte finish rather than a bright shiny one. The coating shall be free of included dust or other particles which would affect the emissivity.

APOLLO G&N Specification
ND1002289 D
Original Issue Date: 4 JAN 1966
Release Authority: TDRR 25004
Class A Release
CODE IDENT. NO. 99974

PROCESS SPECIFICATION

LOW EMISSIVITY COATING

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals AC	Approvals NASA
6/1/66	A	29194	2, 4, 5 DD6/RC	MGM	----
7/1/66	B	29904	5 DD6/RC	MGM	
9/9/66	C	31141	2, 3, 5, 6 Was 6 pages now 7 DD6/RC	EA	ACM
8/31/67	D	34501	6 DD6/RC	MGM EA	----

This specification consists of page 1 to 7 inclusive.

APPROVALS	A. C. METZGER NASA/MSC	A Lemmon 12/30/65 MIT/IL	V. Pagliaro R Respiro	W. Sutherland AC

d. Parts shall be cured in accordance with the following cure schedule:

(1) The area repaired shall be cured 30 hrs min at 135°±5°F.

3.7 TOUCH-UP AT FIELD SITES ONLY

a. Clean the area to be repaired with isopropyl alcohol, distilled water, a second alcohol rinse, and a final Freon T.F. rinse.

b. Mix the paint as follows:

1010657 - Epoxy Resin - 6 PBW
1010686 - Catalyst - 4 PBW
TT-P-320 - Type I, Class A Aluminum Flakes - 1 PBW
The resin, catalyst, and aluminum shall be thoroughly mixed and then brushed on the appropriate areas.

c. Parts shall be cured at room temperature.

3.8 WORKMANSHIP. The coating shall be smooth, bright and uniform in appearance, free from sags, voids or other irregularities which would affect the emissivity. The coating shall show no signs of balling or delamination which would result in a rough matte finish rather than a bright shiny one. The coating shall be free of included dust or other particles which would affect the emissivity.

APOLLO G&N Specification
ND1002289
Original Issue Date: 4 JAN 1966
Release Authority: TDRR 25004
Class A Release
CODE IDENT. NO. 99974

PROCESS SPECIFICATION

LOW EMISSIVITY COATING

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA

This specification consists of page 1 to 6 inclusive.

APPROVALS				
A. C. METZGER	A. Levenson		V. Pagliaro	W. Sutherland
NASA/MSC	12/29/65	MIT/IL	RR&A	ACSP

1. SCOPE

1.1 PURPOSE. This specification describes the process for the formulation and application of a low emissivity coating to anodized aluminum and magnesium.

1.2 CLASSIFICATION. The requirements for the process covered by this specification shall be designated as ND1002289-001. This shall include all requirements specified in Sections 1 through 6 of this specification.

2. APPLICABLE DOCUMENTS

2.1 EFFECTIVE ISSUES. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, Military Standards and Specifications shall be the issue in effect on the date of request for proposal or invitation to bid.

SPECIFICATIONS

Federal

BB-F-671	Freon Gas, Compressed (Chlorofluoro Hydro-carbons)
TT-M-261	Methyl Ethyl Ketone
TT-P-320	Pigment, Aluminum, for Paint
TT-T-548	Toluene, Technical

DRAWINGS

NASA

1010657	Epoxy Resin (Clear)
1010686	Catalyst

PUBLICATIONS

NASA

NPC 200-2	NASA Quality Publication, Quality Program for Space System Contractors

(Copies of specifications, standards, drawings, bulletins, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 CONFLICTING REQUIREMENTS. In event of a conflict between requirements, the following order of precedence shall apply: The contractor shall also notify MIT/IL APOLLO Management of the conflict.

a. The contract
b. This specification
c. Documents listed in this section

3. PROCEDURE

3.1 SURFACE PREPARATION. Where surface contamination is inherent in the fabrication of the part or assembly, the contaminants shall be removed with a solvent or cleaning agent which is compatible with the surface to be coated. Preferred solvent and cleaner materials are methyl ethyl ketone, per Specification TT-M-261 or Freon TF per Specification BB-F-671. Care shall be exercised in the handling of cleaned parts to prevent subsequent surface contamination due to fingerprints, oils, greases, release agents, moisture, dust or other foreign material which would affect the adherence or appearance of the coating.

3.2 MATERIAL. The coating system shall consist of a 2 component epoxy system conforming to the requirements of Drawings 1010657 and 1010686. to which aluminum flake conforming to Specification TT-P-320 Type I, Class A has been added.

3.3 MIXING. The coating shall be mixed in accordance with the following formula:

	Ratio By Weight
1010657	Eccobond 45 clear = 3 parts
1010686	Eccobond Catalyst 15 = 2 parts
TT-T-548	Toluene = 15 parts
TT-P-320	Type I, Class A Alumimum Flake = 4 parts

The resin and catalyst shall be thoroughly mixed by themselves. This mixture is thinned by the addition of toluene. The aluminum flake shall be added to the thinned epoxy system in small increments with continuous stirring. After all materials have been combined, the mixture shall be thoroughly agitated to ensure complete wetting and uniform dispersion of the aluminum flake.

3.3.1 Pot Life. The pot life of the mixed system shall be 2 hours maximum at room temperature.

3.4 APPLICATION. - The following technique shall be used to obtain the desired coating:

a. The method of application shall be by spray only, as this system does not lend itself to brushing.

b. Application pressure shall be 40±5 psi. Excessive spray pressure results in balling up of the aluminum flake and prevents leafing.

c. A minimum dry film thickness of 0.0015" is required to obtain the required emissivity.

d. Continuous agitation during spray is required to keep the pigment well dispersed.

e. The finish shall be applied in multiple coats, allowing 30 minutes minimum flash-off time between coats.

f. Care shall be exercised during and after the application of the finish to prevent dirt, dust, and other particles from contaminating the surface.

3.5 CURE. The applied coating shall be air dried for 30 minutes minimum. To ensure that optimum properties of the finish are obtained, the air-dried coating shall be followed by a force cure of 2 hours minimum at 150°F.

3.6 WORKMANSHIP. The coating shall be smooth, bright and uniform in appearance, free from sags, voids or other irregularities which would affect the emissivity. The coating shall show no signs of balling or delamination which would result in a rough matte finish rather than a bright shiny one. The coating shall be free of included dust or other particles which would affect the emissivity.

4. QUALITY ASSURANCE PROVISIONS

4.1 PROCESS AND QUALITY CONTROL. The processor shall maintain sufficient process and quality control to assure that the requirements of this specification are met in accordance with the provisions of Publication NPC 200-2.

5. PREPARATION FOR DELIVERY. - This section is not applicable to this specification.

6. NOTES

6.1 INTENDED USE. - This specification is intended for use in applying a low emissivity finish to thermal control surfaces.

APOLLO G&N Specification
ND1002290 REV A
Original Issue Date: 15 FEB '66
Release Authority: TDRR 26319
Class A Release
CODE IDENT NO. 99974

PROCESS SPECIFICATION

ELECTRONIC ASSEMBLY EVACUATION, FILL, AND LEAK RATE ACCEPTANCE

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA
6/7/66	A	29427	2, 4, 5, 6 Now 7 pages; was 6 pages. ROG/AC	MGM	--

This specification consists of page 1 to 7 inclusive.

APPROVALS	A. C. METZGER NASA/MSC	A Levanon MIT/IL	W. Ramsey E D Geiger ACSP

1. SCOPE

1.1 PURPOSE. This specification defines the criteria for evacuation, fill, and acceptable leak rate of sealed airborne electronic assemblies designed to withstand APOLLO environment.

1.2 CLASSIFICATION. The requirements for the process covered by this specification shall be classified as follows. Unless identified by the respective type, all requirements of this specification are applicable to all types.

a. Type I: The requirements for ND1002290 Type I shall be:

(1) Maximum pressure differential across header: 15.0 psia.
(2) Leak rate after sealing: See Table II.
(3) Sealed header internal pressure: 13.5 to 15.0 psia.
(4) Fill gas: 100 percent helium, test, evacuate, fill to 10±1 percent helium, balance nitrogen.

b. Type II: The requirements for ND1002290 Type II shall be:

(1) Maximum pressure differential across header: 8 psia
(2) Leak rate after sealing: 1×10^{-5} std cc/sec of helium
(3) Sealed header internal pressure: 7 to 8 psia
(4) Fill gas: 10±1 percent helium, balance of nitrogen

2. APPLICABLE DOCUMENTS

2.1 EFFECTIVE ISSUES. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, Military Standards and Specifications shall be the issue in effect on the date of request for proposal or invitation to bid.

SPECIFICATIONS

Federal

BB-N-411	Nitrogen, Technical Type I, Grade A

DRAWINGS

APOLLO G&N

2021560	Helium, High Purity

(Copies of specifications, standards, drawings, bulletins, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 GENERAL. The gas fill and leak rate check shall be performed after completion of all testing and prior to shipping.

3.2 TEST CONDITIONS. The gas fill and leak rate check shall be performed under the following conditions:

3.2.1 Test Environment

a. Ambient Temperature: 72°F±10°F
b. Relative Humidity: 90% max
c. Barometric Pressure: 28 to 32 inches of Hg

3.3 FILL GAS PURITY

a. Nitrogen shall conform to the requirements of Specification BB-N-411, Type I, Grade A
b. Helium shall conform to the requirements of Drawing 2021560.

3.4 HEADER PRESSURIZATION

3.4.1 Type I

3.4.1.1 Evacuation. Evacuate the assembly to one of the pressures noted in Table I using the appropriate procedure noted in Table I.

3.4.1.2 Pressurization. Pressurize the assembly with 100 percent helium conforming to Drawing 2021560. Seal the assembly at 13.5 psia to 15.0 psia.

3.4.1.3 Preliminary Leak Rate Test. Immediately following the header pressurization a preliminary leak rate test shall be performed using a helium "sniffing" technique for detection of a leak large enough to cause the loss of the header gas fill prior to the final leak rate test.

3.4.1.4 Vacuum Chamber Pressure. The header shall be mounted in a vacuum chamber and the chamber pressure reduced to and maintained at less than 2×10^{-5} mm Hg for 15 minutes minimum prior to the final leak rate test.

3.4.1.5 Leak Rate. The leak rate shall not exceed the values noted in Table II with the header pressurized as specified in 3.4.1.2.

3.4.1.6 After final leak rate test evacuate assembly to a pressure of 1000 microns and then pressurize with a mixture consisting of 10±1 percent helium conforming to Drawing 2021560 and the balance nitrogen per Specification BB-N-411. Seal the assembly at 13.5 to 15.0 psia connected to 29.92 in Hg barometric pressure at 68°F. Install sealing cap on pressure valve. Use a helium "sniffing" technique to verify the pressure valve is sealed.

3.4.2 Type II

3.4.2.1 Evacuation. Evacuate the assembly to a pressure of $5x10^{-2}$ mm of Hg (50 microns) or less and maintain in this condition for a minimum of 5 minutes. The Header shall not be exposed to a pressure differential greater than 8 psia.

TABLE I

MINIMUM ALLOWABLE EVACUATION PRESSURE VS PROCEDURE

EVACUATION PRESSURE (MICRONS)	PROCEDURE
1000	Evacuate to 1000 microns and backfill with 100% nitrogen 2 times. Perform a third evacuation maintaining the indicated pressure for a minimum of 5 minutes. Pressurize per 3.4.1.2
500	Evacuate to 500 microns and backfill with 100% nitrogen. Perform a second evacuation maintaining the indicated pressure for a minimum of 5 minutes. Pressurize per 3.4.1.2
250	Evacuate to the pressure indicated maintaining pressure for a minimum of 5 minutes. Pressurize per 3.4.1.2.

TABLE II

LEAKAGE RATES

ASSEMBLY	MAXIMUM LEAKAGE
PSA 2007200	$1x10^{-3}$ STD CC/SEC
CDU 2007222	$1x10^{-4}$ STD CC/SEC
PSA LEM 6007200	$2.5x10^{-4}$ STD CC/SEC
PEA 2007201	$5x10^{-5}$ STD CC/SEC
PTA 6007000	$5x10^{-5}$ STD CC/SEC

3.4.2.2 Pressurization. Pressurize the header with a mixture consisting of 10±1 percent helium and the balance Nitrogen. The assembly shall be sealed at 7.5±0.5 psia corrected to 29.92 in Hg and 68°F. Install sealing cap on pressure valve prior to leak checking.

3.4.2.3 Preliminary Leak Rate Test. Immediately following the header pressurization a preliminary leak rate test shall be performed using a helium "sniffing" technique for detection of a leak large enough to cause loss of the header fill gas prior to the final leak rate test.

3.4.2.4 Vacuum Chamber Pressure. The header shall be mounted in a vacuum chamber and the chamber pressure reduced to and maintained at less than 2×10^{-5} mm of Hg for 15 minutes minimum prior to the final leak rate test.

3.4.2.5 Leak Rate. The leak rate shall not exceed 1×10^{-5} std cc/sec based on 100 percent helium fill, with the header pressurized as specified in 3.4.2.2.

3.5 PRIOR COMPLIANCE. Prior to evacuation and filling the header assembly shall have met the requirements of the applicable procurement specification.

3.6 TEST FAILURE

3.6.1 Failure Criteria. Failure to meet the requirements of this specification shall constitute failure of the assembly.

4. QUALITY ASSURANCE PROVISIONS

4.1 LEAK CHECK. When tested, using suitable equipment, the assembly shall meet the requirements of this specification.

5. PREPARATION FOR DELIVERY. This section is not applicable to this specification.

6. NOTES. None.

WS:efo

APOLLO G&N Specification
ND1002290 REV B
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CODE IDENT NO. 99974

PROCESS SPECIFICATION

ELECTRONIC ASSEMBLY EVACUATION, FILL, AND LEAK RATE ACCEPTANCE

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals AC	Approvals NASA
(M) 6/7/66	A	29427	2, 4, 5, 6 Now 7 pages; was	MGM	—
			6 pages. ROC/AC		
3/16/67	B	33207	2-6 ROC/AC	MGM, EA	--

This specification consists of page 1 to 7 inclusive.

APPROVALS	A. C. METZGER NASA/MSC	MIT/IL	AC

1. SCOPE

1.1 PURPOSE. This specification defines the criteria for evacuation, fill, and acceptable leak rate of sealed airborne electronic assemblies designed to withstand APOLLO environment.

1.2 CLASSIFICATION. The requirements for the process covered by this specification shall be classified as follows. Unless identified by the respective type, all requirements of this specification are applicable to all types.

a. Type I-a: The requirements for ND1002290, Type I-a shall be:

(1) Maximum pressure differential across header: 15.0 psia.
(2) Leak rate after sealing: See Table II
(3) Sealed header internal pressure: 13.5 to 15.0 psia
(4) Fill gas: 100 percent helium, test, evacuate, fill to 10±1 percent helium, balance nitrogen.

b. Type I-b: The requirements for ND1002290, Type I-b shall be:

(1) Maximum pressure differential across header: 15.0 psia
(2) Leak rate after sealing: See Table III
(3) Sealed header internal pressure: 13.5 to 15.0 psia
(4) Fill gas: 100 percent nitrogen

c. Type II: The requirements for ND1002290, Type II shall be:

(1) Maximum pressure differential across header: 8 psia
(2) Leak rate after sealing: 1×10^{-5} std cc/sec of helium
(3) Sealed header internal pressure: 7 to 8 psia
(4) Fill gas: 10±1 percent helium, balance of nitrogen

1.2.1 Existing Drawings. When a process designation is specified as ND1002290, Type I on the existing drawings, this shall be construed as meaning ND1002290, Type I-a for all testing except field site testing. For field site testing, ND1002290 Type I-a or Type I-b may be used. (Field site shall be construed as any site other than the place of manufacturing.)

2. APPLICABLE DOCUMENTS

2.1 EFFECTIVE ISSUES. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, Military Standards and Specifications shall be the issue in effect on the date of request for proposal or invitation to bid.

SPECIFICATIONS

Federal

BB-N-411 Nitrogen, Technical Type I, Grade A

3.4.1.8 After final leak rate test evacuate assembly to a pressure of 1000 microns and then pressurize with a mixture consisting of 10±1 percent helium conforming to Drawing 2021560 and the balance nitrogen per Specification BB-N-411. Seal the assembly at 13.5 to 15.0 psia corrected to 29.92 in Hg barometric pressure at 68°F. Install sealing cap on pressure valve. Use a helium "sniffing" technique to verify the pressure valve is sealed.

3.4.2. Type I-b .n

3.4.2.1 Evacuation. Evacuate the assembly to one of the pressures noted in Table I using the proper procedure noted in Table I except that final pressurization will be per 3.4.2.2.

3.4.2.2 Pressurization. Pressurize the assembly with 100 percent nitrogen conforming to Specification BB-N-411. Seal the assembly to 13.0 psig to 15.0 psig.

3.4.2.3 Leak Rate. The leak rate shall not exceed values noted in Table III with the assembly pressurized as specified in 3.4.2.2.

3.4.2.4 Final Seal. After the leak test, adjust the assembly pressure to between 13.5 psia to 15.0 psia with 100 percent nitrogen as specified in 3.4.2.2 and install the sealing cap. Correct pressure to 29.92 in Hg barometric pressure at 68°F.

3.4.3 Type II

3.4.3.1 Evacuation. Evacuate the assembly to a pressure of 5×10^{-2}mm of Hg (50 microns) or less and maintain in this condition for a minimum of 5 minutes. The Header shall not be exposed to a pressure differential greater than 8 psia.

3.4.3.2 Pressurization. Pressurize the header with a mixture consisting of 10±2 percent helium and the balance nitrogen. The assembly shall be sealed at 7.5±0.5 psia corrected to 29.92 in Hg and 68°F. Install sealing cap on pressure valve prior to leak checking.

3.4.3.3 Preliminary Leak Rate Test. Immediately following the header pressurization a preliminary leak rate test shall be performed using a helium "sniffing" technique for detection of a leak large enough to cause loss of the header fill gas prior to the final leak rate test.

3.4.3.4 Vacuum Chamber Pressure. The header shall be mounted in a vacuum chamber and the chamber pressure reduced to and maintained at less than 2×10^{-5}mm of Hg for 15 minutes minimum prior to the final leak rate test.

3.4.3.5 Leak Rate. The leak rate shall not exceed 1×10^{-5}std cc/sec based on 100 percent helium fill, with the header pressurized as specified in 3.4.3.2.

3.5 PRIOR COMPLIANCE. Prior to evacuation and filling, the header assembly shall have met the requirements of the applicable procurement specification.

3.6 TEST FAILURE

3.6.1 Failure Criteria. Failure to meet the requirements of this specification shall consistute failure of the assembly.

APOLLO G&N Specification
ND1002290 REV —
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PROCESS SPECIFICATION

ELECTRONIC ASSEMBLY EVACUATION, FILL, AND LEAK RATE ACCEPTANCE

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA

This specification consists of page 1 to 6 inclusive.

APPROVALS	A. C. METZGER		
	NASA/MSC	MIT/IL	ACSP

1. SCOPE

1.1 PURPOSE. This specification defines the criteria for evacuation, fill, and acceptable leak rate of sealed airborne electronic assemblies designed to withstand APOLLO environment.

1.2 CLASSIFICATION. The requirements for the process covered by this specification shall be classified as follows. Unless identified by the respective type, all requirements of this specification are applicable to all types.

a. Type I: The requirements for ND1002290 Type I shall be:

(1) Maximum pressure differential across header: 17.5 psia
(2) Leak rate after sealing: 2×10^{-5} std cc/second of helium.
(3) Sealed header internal pressure: 16 to 17.5 psia.
(4) Fill gas: 10±1 percent helium, balance of nitrogen.

b. Type II: The requirements for ND1002290 Type II shall be:

(1) Maximum pressure differential across header: 8 psia
(2) Leak rate after sealing: 1×10^{-5} std cc/sec of helium
(3) Sealed header internal pressure: 7 to 8 psia
(4) Fill gas: 10±1 percent helium, balance of nitrogen

2. APPLICABLE DOCUMENTS

2.1 EFFECTIVE ISSUES. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, Military Standards and Specifications shall be the issue in effect on the date of request for proposal or invitation to bid.

SPECIFICATIONS

Federal

BB-N-411	Nitrogen, Technical Type I, Grade A

DRAWINGS

APOLLO G&N

2021560	Helium, High Purity

(Copies of specifications, standards, drawings, bulletins, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 CONFLICTING REQUIREMENTS. In event of a conflict between requirements, the following order of precedence shall apply. The contractor shall also notify MIT/IL APOLLO Management of the conflict. .

a. The contract
b. This specification
c. Documents listed in this section

3. REQUIREMENTS

3.1 GENERAL. The gas fill and leak rate check shall be performed after completion of all testing and prior to shipping.

3.2 TEST CONDITIONS. The gas fill and leak rate check shall be performed under the following conditions:

3.2.1 Test Environment

a. Ambient Temperature: 72°F ±10°F
b. Relative Humidity: 90% max
c. Barometric Pressure: 28 to 32 inches of Hg

3.3 FILL GAS PURITY

a. Nitrogen shall conform to the requirements of Specification BB-N-411, Type I, Grade A
b. Helium shall conform to the requirements of Drawing 2021560.

3.4 HEADER PRESSURIZATION

3.4.1 Type I

3.4.1.1 Evacuation. Evacuate the assembly to a pressure of 5×10^{-2} mm of Hg (50 microns) or less and maintain in this condition for a minimum of 5 minutes.

3.4.1.2 Pressurization. Pressurize the assembly with a mixture consisting of 10±1 percent helium conforming to Drawing 2021560 and the balance Nitrogen per Specification BB-N-411. Seal the assembly at 16 psia to 17.5 psia corrected to 29.92 in Hg barometric pressure at 68°F. Install sealing cap on pressure valve prior to leak checking.

3.4.1.3 Preliminary Leak Rate Test. Immediately following the header pressurization a preliminary leak rate test shall be performed using a helium "sniffing" technique for detection of a leak large enough to cause the loss of the header gas fill prior to the final leak rate test.

3.4.1.4 Vacuum Chamber Pressure. The header shall be mounted in a vacuum chamber and the chamber pressure reduced to and maintained at less than 2×10^{-5} mm Hg for 15 minutes minimum prior to the final leak rate test.

3.4.1.5 Leak Rate. The leak rate shall not exceed 2×10^{-5} std cc/sec based on 100 percent helium fill with the header pressurized as specified in 3.4.12.

3.4.2 Type II

3.4.2.1 Evacuation. Evacuate the assembly to a pressure of 5×10^{-2} mm of Hg (50 microns) or less and maintain in this condition for a minimum of 5 minutes. The Header shall not be exposed to a pressure differential greater than 8 psia.

3.4.2.2 Pressurization. Pressurize the header with a mixture consisting of 10±1 percent helium and the balance Nitrogen. The assembly shall be sealed at 7.5±0.5 psia corrected to 29.92 in Hg and 68°F. Install sealing cap on pressure valve prior to leak checking.

3.4.2.3 Preliminary Leak Rate Test. Immediately following the header pressurization a preliminary leak rate test shall be performed using a helium "sniffing" technique for detection of a leak large enough to cause loss of the header fill gas prior to the final leak rate test.

3.4.2.4 Vacuum Chamber Pressure. The header shall be mounted in a vacuum chamber and the chamber pressure reduced to and maintained at less than 2×10^{-5} mm of Hg for 15 minutes minimum prior to the final leak rate test.

3.4.2.5 Leak Rate. The leak rate shall not exceed 1×10^{-5} std cc/sec based on 100 percent helium fill, with the header pressurized as specified in 3.4.2.2.

3.5 PRIOR COMPLIANCE. Prior to evacuation and filling the header assembly shall have met the requirements of the applicable procurement specification.

3.6 TEST FAILURE

3.6.1 Failure Criteria. Failure to meet the requirements of this specification shall constitute failure of the assembly.

4. QUALITY ASSURANCE PROVISIONS

4.1 LEAK CHECK. When tested, using suitable equipment, the assembly shall meet the requirements of this specification.

5. PREPARATION FOR DELIVERY. This section is not applicable to this specification.

6. NOTES. None.

WS: efo

APOLLO G&N Specification
ND1002291 REV – A
Original Issue Date: 2/23/66
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PROCESS SPECIFICATION

FINISHING WITH POLYESTER ENAMEL

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals MIT	Approvals NASA
5/3/66	A	28424	1, 2, 4, 5, 6 Now 7 pages, was 6 pages.	WK	–

This specification consists of page 1 to 7 inclusive.

APPROVALS	C. METZGER NASA/MSC	G Lewman MIT/IL	O.J. Bjorgard ACSP

1. SCOPE

1.1 PURPOSE. This specification describes the process for the application of a corrosion-resistant finish to metallic substrates.

1.2 CLASSIFICATION. The requirements for the process covered by this specification shall be designated as ND1002291-001. This shall include all requirements specified in Sections 1 through 6 of this specification.

2. APPLICABLE DOCUMENTS

2.1 EFFECTIVE ISSUES. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, Military Standards and Specifications shall be the issue in effect on the date of request for proposal or invitation to bid.

SPECIFICATIONS

Federal

TT-M-261	Methyl Ethyl Ketone
O-T-634	Trichloroethylene, Technical,
TT-N-95	Naphtha, Aliphatic
TT-X-916	Zylene (for use in organic coatings)
TT-T-548	Toluene (for use in organic coatings)

Military

MIL-P-8585	Primer Coating, Low Moisture Sensitivity

DRAWINGS

NASA

1012543	Coating Kit, Light Diffusing

3. PROCEDURE

3.1 MATERIAL. The coatings used shall be a zinc chromate primer in accordance with Specification MIL-P-8585 and a gray enamel topcoat (two component polyester system) in accordance with Drawing 1012543-003.

3.2 PROCESS

3.2.1 Cleaning. All surfaces to be coated shall be thoroughly solvent-cleaned to remove contamination. Solvents used shall be trichloroethylene in accordance with Specification O-T-634 Type I or II and methyl ethyl ketone in accordance with Specification TT-M-261. Piece parts shall be cleaned by vapor degreasing in trichloroethylene followed by scrubbing with methyl ethyl ketone. Assemblies shall be cleaned by wiping with tissue paper moistened with solvent. Trichloroethylene shall be used first followed by methyl ethyl ketone. Solvent cleaning shall be repeated as necessary, using fresh solvent and tissue paper, to achieve a surface capable of passing the water-break test of 3.2.1.2; however, if repeated cleaning (not less than four times in each solvent) fails to yield a water-break-free surface, the primer wetting test of 3.2.1.3 shall be used. In addition to the above cleaning procedure, surfaces which have received pretreatment (chemical film or anodize) shall be washed with distilled or deionized water to remove water soluble soils followed by a wash with methyl ethyl ketone to dry the surfaces. Water shall not be allowed to remain on surfaces longer than necessary for adequate cleaning.

3.2.1.1 Caution. Caution shall be exercised when using the tissue paper cleaning method on equipment to insure that excess solvent is not used. Running or dripping of solvent on equipment shall be avoided.

3.2.1.2 Water-break Test Procedure. Representative areas of the cleaned surface shall be tested for ability to support an unbroken film of distilled water by applying a few drops to the surface and observing if the surface is wetted when the water is moved with a metal or glass probe.

3.2.1.3 Alternate Primer Wetting Test. Zinc chromate primer, thinned in accordance with this specification, shall be brushed on representative areas of the cleaned surface. Visual examination of the drying film shall be performed to determine freedom from areas not wetted by primer as evidenced by crawling in the film, fish eyes, or holidays. The primer shall be removed with toluene-moistened tissue paper before proceeding.

3.2.1.4 Location. Cleaning shall be performed in a well-ventilated area such as in a fume hood or in front of an exhausting paint spray booth. Rubber gloves shall be used.

3.2.2 Masking. All tapped-and through-holes shall be plugged prior to painting. Masking of other areas designated to be free of the coating shall be accomplished with masking tape of a type suitable for baking. The masking tape shall be applied and trimmed as necessary to produce an even edge in conformance with the dimensional requirements of the masked area. All materials selected for masking shall be capable of withstanding a temperature of +140°F. Gloves shall be used while masking to insure that cleaned surfaces remain uncontaminated.

3.2.3 Priming

3.2.3.1 Primer. Zinc chromate primer shall be be thoroughly mixed in the original container to assure admixture of the ingredients. The mixed primer shall be thinned with toluene in accordance with Specification TT-T-548 to obtain a viscosity of 26 to 34 seconds in a No. 1 Zahn cup or equivalent. The thinned primer shall then be strained through nylon or cotton cloth.

3.2.3.2 Application. The prepared primer shall be applied to freshly cleaned surfaces by spraying to a dry film thickness of 0.0003 to 0.0004 inch. The prerequisite thickness produces a distinct greenish cast; a full yellow cast indicates the primer is too thick. The dried primer shall have a smooth appearance and shall be free of dusting and overspray.

3.2.3.3 Curing. The primer shall be cured at room temperature for not less than 1-1/2 hrs and not more than 24 hrs before overcoating with polyester enamel.

3.2.4 Enameling

3.2.4.1 Enamel. Polyester enamel shall be prepared for spraying by thoroughly mixing each component and then adding one part by volume of component No. 2 (clear) to three parts by volume of component No. 1 (pigmented). The catalized enamel shall immediately be mixed and then allowed to stand for 30 minutes minimum before use. Up to 15 percent by volume of xylene in accordance with Specification TT-X-916, Grade A, as desired, may be added to thin the enamel for use with a siphon-type spray gun. No thinner shall be used when the enamel is applied with a pressure-type spray gun. The enamel shall be strained through cotton or nylon cloth. The pot life of the catalized enamel is 48 hours.

3.2.4.2 Application. The enamel shall be applied by spraying using agitation as required to prevent settling of the pigments. The enamel shall be applied with a full wet coat to a dry film thickness of 1-1/2 to 2 mils (normally one pass is required). Overcoating areas which have started to dry shall be avoided as film lifting may occur. If overcoating is necessary, not less than one hour at room temperature shall be provided as the minimum cure time.

3.2.4.3 Baking. After allowing a solvent flash-off time of 15 minutes minimum, the enameled equipment shall be baked at a metal temperature of +135° ±5°F for 24 hrs.

3.2.5 Masking Removal. After the equipment has cooled to room temperature, the masking shall be removed. Naptha, in accordance with Specification TT-N-95, Type I or Type II, shall be used to clean the surfaces which were in contact with the masking, using care to insure that no running or dripping of the solvent occurs on the equipment.

3.2.6 Touch-Up. Edges adjacent to the masking shall be feathered to the surrounding surface with a suitable tool or mild abrasive. The entire finished surfaces shall be lightly rubbed with rubberized bound hair or tampico fiber to remove loosely adherent overspray. Damaged and local areas shall be touched-up by brush, spray or other suitable means of application of primer

and enamel in accordance with all of the requirements of this specification except air drying for two hours minimum shall be considered an alternate to baking if the touched-up area is less than 4 sq. in.

3.3 WORKMANSHIP. The applied coating shall be uniform in appearance, and free from voids, sags, runs, or other irregularities. The coating shall show no signs of loosely adherent overspray.

4. QUALITY ASSURANCE PROVISIONS

4.1 PROCESS AND QUALITY CONTROL. The processor shall maintain sufficient process and quality control to assure that the requirements of this specification are met in accordance with the provisions of Publication NPC 200-2.

5. PREPARATION FOR DELIVERY. This section is not applicable to this specification.

6. NOTES

6.1 INTENDED USE. This specification is intended for use in applying a low-outgassing, corrosion-resistant finish to metallic surfaces. .

6.2 CLEANING. Cleanliness is extremely important to obtain adequate adhesion of organic finishes to beryllium or any other bare metal surface. Care should be exercised to insure that parts are cleaned thoroughly and that cleanliness is maintained throughout the finishing process. Cleaned parts should not be touched with bare hands.

OJR:jls

APOLLO G&N Specification
ND1002291 REV – B
Original Issue Date: 2/27/66
Release Authority: TDRR 26638
Class A Release
CODE IDENT NO. 99974

PROCESS SPECIFICATION

FINISHING WITH POLYESTER ENAMEL

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals MIT	Approvals NASA
(N) 5/3/66	A	28424	1, 2, 4, 5, 6 Now 7 pages, was 6 pages. DCL/av	WK	–
7/5/66	B	30074	2, 5, 6 DCL/av	MGM	–

This specification consists of page 1 to 7 inclusive.

APPROVALS	C. MELTZER NASA/MSC	G Levinson MIT/IL WK	O.J. Ryzyard L Stugis D K Kupfer ACSP

1. SCOPE

1.1 PURPOSE. This specification describes the process for the application of a corrosion-resistant finish to metallic substractes.

1.2 CLASSIFICATION. The requirements for the process covered by this specification shall be designated by the applicable type or dash number. This shall include all requirements specified in Sections 1 through 6 of this specification.

Type		Dash No.
I	Low Temperature Cure	ND-1002291-001
II	Intermediate Temperature Cure	ND-1002291-002
III	High Temperature Cure	ND-1002291-003

NOTE: Where no type of cure is specified by the applicable drawing, the Type I cure shall be used.

2. APPLICABLE DOCUMENTS

2.1 EFFECTIVE ISSUES. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, Military Standards and Specifications shall be the issue in effect on the date of request for proposal or invitation to bid.

SPECIFICATION

Federal

TT-M-261	Methyl Ethyl Ketone
O-T-634	Trichlorethylene, Technical,
TT-N-95	Naphtha, Aliphatic
TT-X-916	Zylene (for use in organic coatings)
TT-T-548	Toluene (for use in organic coatings)

Military

MIL-P-8585	Primer Coating, Low Moisture Sensitivity

DRAWINGS

NASA

1012543	Coating Kit, Light Diffusing

3.2.3 Priming

3.2.3.1 Primer. Zinc chromate primer shall be thoroughly mixed in the original container to assure admixture of the ingredients. The mixed primer shall be thinned with toluene in accordance with Specification TT-T-548 to obtain a viscosity of 26 to 34 seconds in a No. 1 Zahn cup or equivalent. The thinned primer shall then be strained through nylon or cotton cloth.

3.2.3.2 Application. The prepared primer shall be applied to freshly cleaned surfaces by spraying to a dry film thickness of 0.0003 to 0.0004 inch. The prerequisite thickness produces a distinct greenish cast; a full yellow cast indicates the primer is too thick. The dried primer shall have a smooth appearance and shall be free of dusting and overspray.

3.2.3.3 Curing. The primer shall be cured at room temperature for not less than 1-1/2 hrs and not more than 24 hrs before overcoating with polyester enamel.

3.2.4 Enameling

3.2.4.1 Enamel. Polyester enamel shall be prepared for spraying by thoroughly mixing each component and then adding one part by volume of component No. 2 (clear) to three parts by volume of component No. 1 (pigmented). The catalized enamel shall immediately be mixed and then allowed to stand for 30 minutes minimum before use. Up to 15 percent by volume of xylene in accordance with Specification TT-X-916, Grade A, as desired, may be added to thin the enamel for use with a siphon-type spray gun. No thinner shall be used when the enamel is applied with a pressure-type spray gun. The enamel shall be strained through cotton or nylon cloth. The pot life of the catalized enamel is 48 hours.

3.2.4.2 Application. The enamel shall be applied by spraying using agitation as required to prevent settling of the pigments. Unless otherwise specified, the enamel shall be applied with a full wet coat to a dry film thickness of 1-1/2 to 2 mils (normally one pass is required). Overcoating areas which have started to dry shall be avoided as film lifting may occur. If overcoating is necessary, not less than one hour at room temperature shall be provided as the minimum cure time.

3.2.4.3 Baking. After allowing a solvent flash-off time of 15 minutes minimum, the enameled equipment shall be baked at a metal temperature in accordance with the following cure schedules as applicable. If no schedule is specified the cure shall be in accordance with the Type I schedule.

Type I:	135±5°F for 24 hrs. minimum
Type II:	150±5°F for 24 hrs. minimum
Type III:	250±5°F for 30 minutes minimum

3.2.5 Masking Removal. After the equipment has cooled to room temperature, the masking shall be removed. Naptha, in accordance with Specification TT-N-95, Type I or Type II, shall be used to clean the surfaces which were in contact with the masking, using care to insure that no running or dripping of the solvent occurs on the equipment.

3.2.6 Touch-Up. Edges adjacent to the masking shall be feathered to the surrounding surface with a suitable tool or mild abrasive. The entire finished surfaces shall be lightly rubbed with rubberized bound hair or tampico fiber to remove loosely adherent overspray. Damaged and local areas shall be touched-up by brush, spray or other suitable means of application of primer

and enamel in accordance with all of the requirements of this specification except air drying for 12 hours minimum shall be considered an alternate to baking if the touched-up area is less than 4 sq. in.

3.3 WORKMANSHIP. The applied coating shall be uniform in appearance, and free from voids, sags, runs, or other irregularities. The coating shall show no signs of loosely adherent overspray.

APOLLO G&N Specification
ND1002291 REV – C
Original Issue Date: 2/27/66
Release Authority: TDRR 26638
Class A Release
CODE IDENT NO. 99974

PROCESS SPECIFICATION

FINISHING WITH POLYESTER ENAMEL

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals MIT	Approvals NASA
(2) 5/3/66	A	28424	1, 2, 4, 5, 6 Now 7 pages, was	WK	–
			6 pages. (2)6/AC		
(3) 7/5/66	B	30074	2, 5, 6 (3)6/AC	MGM	–
9/22/66	C	31275	2, 4, 5, 6 RM/MM	EA	–

This specification consists of page 1 to 7 inclusive.

APPROVALS	A. C. METZGER NASA/MSC	G Levinson MIT/IL WK for 23 Feb 66	O.J. Bryggard L Kingsley R.R. Kupfer ACSP

1. SCOPE

1.1 PURPOSE. This specification describes the process for the application of a corrosion-resistant finish to metallic substractes.

1.2 CLASSIFICATION. The requirements for the process covered by this specification shall be designated by the applicable type or dash number. This shall include all requirements specified in Sections 1 through 6 of this specification.

Type		Dash No.
I	Low Temperature Cure	ND-1002291-001
II	Intermediate Temperature Cure	ND-1002291-002
III	High Temperature Cure	ND-1002291-003

NOTE: Where no type of cure is specified by the applicable drawing, the Type I cure shall be used.

2. APPLICABLE DOCUMENTS

2.1 EFFECTIVE ISSUES. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, Military Standards and Specifications shall be the issue in effect on the date of request for proposal or invitation to bid.

SPECIFICATION

Federal

TT-M-261	Methyl Ethyl Ketone
O-T-634	Trichlorethylene, Technical,
TT-N-95	Naphtha, Aliphatic
TT-X-916	Zylene (for use in organic coatings)
TT-T-548	Toluene (for use in organic coatings)

Military

MIL-P-8585	Primer Coating, Low Moisture Sensitivity
MIL-P-15328	Primer Pretreatment

DRAWINGS

NASA

1012543	Coating Kit, Light Diffusing

3. PROCEDURE

3.1 MATERIAL. The coatings used shall be a zinc chromate primer in accordance with Specification MIL-P-8585 and a gray enamel topcoat (two component polyester system) in accordance with Drawing 1012543-003. If desired, a primer pre-treatment per MIL-P-15328 may be used.

3.2 PROCESS

3.2.1 Cleaning. All surfaces to be coated shall be thoroughly solvent-cleaned to remove contamination. Solvents used shall be trichloroethylene in accordance with Specification O-T-634 Type I or II and methyl ethyl ketone in accordance with Specification TT-M-261. Piece parts shall be cleaned by vapor degreasing in trichloroethylene followed by scrubbing with methyl ethyl ketone. Assemblies shall be cleaned by wiping with tissue paper moistened with solvent. Trichloroethylene shall be used first followed by methyl ethyl ketone. Solvent cleaning shall be repeated as necessary, using fresh solvent and tissue paper, to achieve a surface capable of passing the water-break test of 3.2.1.2; however, if repeated cleaning (not less than four times in each solvent) fails to yield a water-break-free surface, the primer wetting test of 3.2.1.3 shall be used. In addition to the above cleaning procedure, surfaces which have received pretreatment (chemical film or anodize) shall be washed with distilled or deionized water to remove water soluble soils followed by a wash with methyl ethyl ketone to dry the surfaces. Water shall not be allowed to remain on surfaces longer than necessary for adequate cleaning.

3.2.1.1 Caution. Caution shall be exercised when using the tissue paper cleaning method on equipment to insure that excess solvent is not used. Running or dripping of solvent on equipment shall be avoided.

3.2.1.2 Water-break Test Procedure. Representative areas of the cleaned surface shall be tested for ability to support an unbroken film of distilled water by applying a few drops to the surface and observing if the surface is wetted when the water is moved with a metal or glass probe.

3.2.1.3 Alternate Primer Wetting Test. Zinc chromate primer, thinned in accordance with this specification, shall be brushed on representative areas of the cleaned surface. Visual examination of the drying film shall be performed to determine freedom from areas not wetted by primer as evidenced by crawling in the film, fish eyes, or holidays. The primer shall be removed with toluene-moistened tissue paper before proceeding.

3.2.1.4 Location. Cleaning shall be performed in a well-ventilated area such as in a fume hood or in front of an exhausting paint spray booth. Rubber gloves shall be used.

3.2.2 Masking. All tapped and through-holes shall be plugged prior to painting. Masking of other areas designated to be free of the coating shall be accomplished with masking tape of a type suitable for baking. The masking tape shall be applied and trimmed as necessary to produce an even edge in conformance with the dimensional requirements of the masked area. All materials selected for masking shall be capable of withstanding the maximum temperature of cure cycle selected from table in Paragraph 3.2.4.3. Gloves shall be used while masking to insure that cleaned surfaces remain uncontaminated.

3.2.3 Priming

3.2.3.1 Primer Pretreatment If Used. Primer pretreatment shall be mixed in accordance with MIL-P-15328.

> Caution: The wash primer shall be applied within 8 hours of the addition of the acid component. Zinc chromate primer shall be applied over pretreatment within 2 hours of completion of pretreatment cure.

3.2.3.2 Application. The prepared primer pretreatment shall be applied to a dry film thickness of 0.0003 to 0.0004 inch.

3.2.3.3 Curing. The primer pretreatment shall be cured at room temperature for not less than 30 minutes.

3.2.3.4 Primer. Zinc chromate primer shall be thoroughly mixed in the original container to assure admixture of the ingredients. The mixed primer shall be thinned with toluene in accordance with Specification TT-T-548 to obtain a viscosity of 26 to 34 seconds in a No. 1 Zahn cup or equivalent. The thinned primer shall then be strained through nylon or cotton cloth.

3.2.3.5 Application. The prepared primer shall be applied to freshly cleaned surfaces by spraying to a dry film thickness of 0.0003 to 0.0004 inch. The prerequisite thickness produces a distinct greenish cast; a full yellow cast indicates the primer is too thick. The dried primer shall have a smooth appearance and shall be free of dusting and overspray.

3.2.3.6 Curing. The primer shall be cured at room temperature for not less than 1-1/2 hrs and not more than 24 hrs before overcoating with polyester enamel.

3.2.4 Enameling

3.2.4.1 Enamel. Polyester enamel shall be prepared for spraying by thoroughly mixing each component and then adding one part by volume of component No. 2 (clear) to three parts by volume of component No. 1 (pigmented). The catalized enamel shall immediately be mixed and then allowed to stand for 30 minutes minimum before use. Up to 15 percent by volume of xylene in accordance with Specification TT-X-916, Grade A, as desired, may be added to thin the enamel for use with a siphon-type spray gun. No thinner shall be used when the enamel is applied with a pressure-type spray gun. The enamel shall be strained through cotton or nylon cloth. The pot life of the catalized enamel is 48 hours.

3.2.4.2 Application. The enamel shall be applied by spraying using agitation as required to prevent settling of the pigments. Unless otherwise specified, the enamel shall be applied with a full wet coat to a dry film thickness of 1-1/2 to 5 mils (normally one pass is required). Overcoating areas which have started to dry shall be avoided as film lifting may occur. If overcoating is necessary, not less than one hour at room temperature shall be provided as the minimum cure time.

3.2.4.3 Baking. After allowing a solvent flash-off time of 15 minutes minimum, the enameled equipment shall be baked at a metal temperature in accordance with the following cure schedules as applicable. If no schedule is specified the cure shall be in accordance with the Type I schedule.

Type I:	135±5° F for 24 hrs. minimum
Type II:	150±5° F for 24 hrs. minimum
Type III:	250±5° F for 30 minutes minimum

APOLLO G&N Specification
ND1002291 REV –
Original Issue Date: 2/27/66
Release Authority: TDRR 26638
Class A Release
CODE IDENT NO. 99974

PROCESS SPECIFICATION

FINISHING OF BERYLLIUM

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA

This specification consists of page 1 to 6 inclusive.

APPROVALS	A. C. METZGER	G Levenson	O.J. Ryzowski	L Stigney
	NASA/MSC	MIT/IL	ACSP	

1. SCOPE

1.1 PURPOSE. This specification describes the process for the application of a corrosion-resistant finish to bare metallic beryllium.

1.2 CLASSIFICATION. The requirements for the process covered by this specification shall be designated as ND1002291-001. This shall include all requirements specified in Sections 1 through 6 of this specification.

2. APPLICABLE DOCUMENTS

2.1 EFFECTIVE ISSUES. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, Military Standards and Specifications shall be the issue in effect on the date of request for proposal or invitation to bid.

SPECIFICATIONS

Federal

TT-M-261	Methyl Ethyl Ketone
O-T-620	Trichloroethylene, Technical, Inhibited
TT-N-95	Naphtha, Aliphatic
TT-X-916	Zylene (for use in organic coatings)
TT-T-548	Toluene (for use in organic coatings)

Military

MIL-P-8585	Primer Coating, Low Moisture Sensitivity

DRAWINGS

NASA

1012543	Coating Kit, Light Diffusing

PUBLICATIONS

NASA

NPC 200-2 NASA Quality Publication, Quality Control Program for Space System Contractors

(Copies of specifications, standards, drawings, bulletins, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 CONFLICTING REQUIREMENTS. In event of a conflict between requirements, the following order of precedence shall apply. The contractor shall also notify MIT/IL APOLLO Management of the conflict.

a. The contract
b. This specification
c. Documents listed in this section

3. PROCEDURE

3.1 MATERIAL. The coatings used shall be a zinc chromate primer in accordance with Specification MIL-P-8585 and a gray enamel topcoat (two component polyester system) in accordance with Drawing 1012543-002.

3.2 PROCESS

3.2.1 Cleaning. All surfaces to be coated shall be thoroughly solvent-cleaned to remove contamination. Solvents used shall be trichloroethylene in accordance with Specification O-T-620 and methyl ethyl ketone in accordance with Specification TT-M-261. Piece parts shall be cleaned by vapor degreasing in trichloroethylene followed by scrubbing with methyl ethyl ketone. Assemblies shall be cleaned by wiping with tissue paper moistened with solvent. Trichloroethylene shall be used first followed by methyl ethyl ketone. Solvent cleaning shall be repeated as necessary, using fresh solvent and tissue paper, to achieve a surface capable of passing the water-break test of 3.2.1.2; however, if repeated cleaning (not less than four times in each solvent) fails to yield a water-break-free surface, the primer wetting test of 3.2.1.3 shall be used.

3.2.1.1 Caution. Caution shall be exercised when using the tissue paper cleaning method on equipment to insure that excess solvent is not used. Running or dripping of solvent on equipment shall be avoided.

3.2.1.2 Water-break Test Procedure. Representative areas of the cleaned surface shall be tested for ability to support an unbroken film of distilled water by applying a few drops to the surface and observing if the surface is wetted when the water is moved with a metal or glass probe.

3.2.1.3 Alternate Primer Wetting Test. Zinc chromate primer, thinned in accordance with this specification, shall be brushed on representative areas of the cleaned surface. Visual examination of the drying film shall be performed to determine freedom from areas not wetted by primer as evidenced by crawling in the film, fish eyes, or holidays. The primer shall be removed with toluene-moistened tissue paper before proceeding.

3.2.1.4 Location. Cleaning shall be performed in a well-ventilated area such as in a fume hood or in front of an exhausting paint spray booth. Rubber gloves shall be used.

3.2.2 Masking. All tapped- and through-holes shall be plugged prior to painting. Masking of other areas designated to be free of the coating shall be accomplished with masking tape of a type suitable for baking. The masking tape shall be applied and trimmed as necessary to produce an even edge in conformance with the dimensional requirements of the masked area. All materials selected for masking shall be capable of withstanding a temperature of +140°F. Gloves shall be used while masking to insure that cleaned surfaces remain uncontaminated.

3.2.3 Priming

3.2.3.1 Primer. Zinc chromate primer shall be be thoroughly mixed in the original container to assure admixture of the ingredients. The mixed primer shall be thinned with toluene in accordance with Specification TT-T-548 to obtain a viscosity of 26 to 34 seconds in a No. 1 Zahn cup or equivalent. The thinned primer shall then be strained through nylon or cotton cloth.

3.2.3.2 Application. The prepared primer shall be applied to freshly cleaned surfaces by spraying to a dry film thickness of 0.0003 to 0.0004 inch. The prerequisite thickness produces a distinct greenish cast; a full yellow cast indicates the primer is too thick. The dried primer shall have a smooth appearance and shall be free of dusting and overspray.

3.2.3.3 Curing. The primer shall be cured at room temperature for not less than 1-1/2 hrs and not more than 24 hrs before overcoating with polyester enamel.

3.2.4 Enameling

3.2.4.1 Enamel. Polyester enamel shall be prepared for spraying by thoroughly mixing each component and then adding one part by volume of component No. 2 (clear) to three parts by volume of component No. 1 (pigmented). The catalized enamel shall immediately be mixed and then allowed to stand for 30 minutes minimum before use. Up to 15 percent by volume of xylene in accordance with Specification TT-X-916, Grade A, as desired, may be added to thin the enamel for use with a siphon-type spray gun. No thinner shall be used when the enamel is applied with a pressure-type spray gun. The enamel shall be strained through cotton or nylon cloth. The pot life of the catalized enamel is 48 hours.

3.2.4.2 Application. The enamel shall be applied by spraying using agitation as required to prevent settling of the pigments. The enamel shall be applied with a full wet coat to a dry film thickness of 1-1/2 to 2 mils (normally one pass is required). Overcoating areas which have started to dry shall be avoided as film lifting may occur. If overcoating is necessary, not less than one hour at room temperature shall be provided as the minimum cure time.

3.2.4.3 Baking. After allowing a solvent flash-off time of 15 minutes minimum, the enameled equipment shall be baked at a metal temperature of +135° ±5°F for 24 hrs.

3.2.5 Masking Removal. After the equipment has cooled to room temperature, the masking shall be removed. Naptha, in accordance with Specification TT-N-95, Type I or Type II, shall be used to clean the surfaces which were in contact with the masking, using care to insure that no running or dripping of the solvent occurs on the equipment.

3.2.6 Touch-Up. Edges adjacent to the masking shall be feathered to the surrounding surface with a suitable tool or mild abrasive. The entire finished surfaces shall be lightly rubbed with rubberized bound hair or tampico fiber to remove loosely adherent overspray.

3.3 WORKMANSHIP. The applied coating shall be uniform in appearance, and free from voids, sags, runs, or other irregularities. The coating shall show no signs of loosely adherent overspray.

4. QUALITY ASSURANCE PROVISIONS

4.1 PROCESS AND QUALITY CONTROL. The processor shall maintain sufficient process and quality control to assure that the requirements of this specification are met in accordance with the provisions of Publication NPC 200[illegible].

5. PREPARATION FOR DELIVERY.

This section is not applicable to this specification.

6. NOTES

6.1 INTENDED USE. This specification is intended for use in applying a low-outgassing, corrosion-resistant finish to beryllium surfaces.

6.2 CLEANING. Cleanliness is extremely important to obtain adequate adhesion of organic finishes to beryllium or any other bare metal surface. Care should be exercised to insure that parts are cleaned thoroughly and that cleanliness is maintained throughout the finishing process. Cleaned parts should not be touched with bare hands.

OJR:jls

PROCESS SPECIFICATION SPECIAL CONDITIONING OF WELDABLE MULTILAYER CIRCUIT BOARDS

1. SCOPE

1.1 PURPOSE

This specification establishes the minimum requirements for the acceptance of weldable, multilayer circuit boards for use in flyable deliverable end items. The procedures described herein shall be performed by the G&N industrial contractor as part of the incoming inspection.

2. APPLICABLE DOCUMENTS

2.1 EFFECTIVE ISSUES

The following documents of the issue in effect on the date of this document form a part of this specification to the extent described herein.

SPECIFICATIONS

MILITARY

MIL-STD-202	Test method for electronic and electrical component parts.
ND 1002271	Process Specification for Weldable Surface Multilayer Printed Wiring Boards.

DRAWINGS

Apollo G&N

1006395	Circuit Board, Multilayer

3. REQUIREMENTS

3.1 GENERAL

The provisions of this specification shall be applicable to all phases of acceptance of weldable multilayer circuit boards SCD 1006395 to the extent specified herein. Specification requirements or provisions not covered by this specification shall be as specified on the applicable drawing or purchase order. In the event of conflict between the requirements of the applicable drawings, this specification and other documents cited herein, the requirements of the applicable drawings and this specification shall govern in that order.

3.2 PROCESS CONTROL

The process covered by this specification shall be controlled in accordance with the provision of Section 4.

Apollo Specification
ND 1002293
Original Issue Date:
Release Authority: TDRR
Class A Release 26210

PROCESS SPECIFICATION SPECIAL CONDITIONING OF WELDABLE MULTILAYER CIRCUIT BOARDS

	DATE	REVISION	TDRR	PAGES REVISED	APPROVALS	
					MIT	NASA
(M)	3/15/66	A	27198	All Pages		

THIS SPECIFICATION CONSISTS OF PAGES 1 TO 8 INCLUSIVE.

APPROVALS			
	A. C. METZGER NASA/MSC	MIT/IL	RAYTHEON

3.2.1 LOT CONTROL - COUPON AND BOARD

A test coupon attached to each board during fabrication shall bear the same serial number as its respective board. The coupon, being simultaneously subjected to all processes, shall reflect the same standards of quality as the board and shall be indicative of all inherent features of the board encompassing circuit construction, circuit performance and overall quality. The coupon shall include test circuits as specified in SCD 1006395. Both the coupon and board shall be subjected to tests outlined in paragraph 3.3.

3.3 TEST PROCEDURE

3.3.1 TEST SEQUENCE FOR MULTILAYER BOARDS

All boards to be flight qualified shall be subjected to the following tests:

a. External visual (test #1).

b. Physical dimension (test #2).

c. Electrical test at 25°C (test #3)

d. Thermal cycle (test #4)

e. Electrical test at 25°C (test #5)

3.3.2 TEST SEQUENCE FOR COUPON

All coupons as specified in SCD 1006395 shall be subjected to the following tests:

a. Thermal storage (test #6).

b. Thermal shock (test #7).

c. Weld pull test (test #8).

d. Sectioning of holes (test #9).

3.3.3 REMOVAL OF FAILURES

Coupons which fail shall be removed from the test sequence at the point of detection and subjected to failure analysis. Multilayer boards which fail shall complete the test sequence after which they shall be subjected to failure analysis. The location in the test sequence where failures occur must be recorded.

3.3.4.4 (Cont'd)

The DC resistance of any conductor shall be less than 4 ohms (.3 ohms attributable to the conductor and the balance of 3.7 ohms to test fixturing.) The insulation resistance between each conductor and all other conductors shall not be less than 30 megohms with 100 VDC.

COUPON TEST

3.3.4.5 THERMAL STORAGE (TEST #6)

All coupons shall be subjected to the following, during which time provision shall be made to continuously monitor for all opens and intermittents(.25 microseconds).

a. Thermal storage at + 165 ± 5°C - 8 hours minimum.

b. Thermal storage at - 65 ± 5°C - 8 hours minimum.

3.3.4.6 THERMAL SHOCK (TEST #7)

Immediately following test 3.3.4.5 (thermal storage), all coupons shall be subjected to the following continuously monitored for all opens and intermittents (.25 microseconds). The following test shall be performed in accordance with MIL-STD-202, Method 107B except that the temperature and time shall be those listed below:

Three cycles, 30 minute minimum residence at extremes of -65 ± 5°C and +165 ± 5°C. Transfer time between extremes shall not exceed 10 seconds.

3.3.4.7 WELD PULL TEST (TEST #7)

A weld pull test shall be performed on the pads of the coupon of SCD 1006390. A flat Kovar wire .015 ± .001 in wide, .005 in thick with 100-200 microinches of gold shall be used for the pull tests. The pull test shall be performed parallel to the surface of the plane of the board (± 5°) and must meet the minimum of 3.6 pounds.

3.3.4.8 SECTIONING OF HOLES (TEST #9)

The plated through holes of the coupon specified in SCD 1006395 shall be sectioned and examined under 80 power minimum magnification for conformance to the following criteria:

The minimum plated copper thickness in the plated thru holes shall be .0015 inches over 75 percent of the cross-sectioned hole. The remaining 25 percent may exhibit a maximum of 3 of the following conditions on each side of a hole.

1. An area which has a minimum plated thickness of .005 inches and a maximum length of .002 inches, provided it does not appear at the hole-conductor interface, and a similar condition does not appear on the adjacent side of the hole indicating a ring.

3.3.4.8 (Cont'd)

2. An area which has a minimum plated thickness of .001 inches and a maximum length of .005 inches, provided it does not appear at the hole-conductor interface.

Sectioning of holes need not be performed in sequential order.

3.4 REMOVAL OF FAILURES

Boards which fail the test sequence 3.3.1 shall be removed at the completion of all tests. Any coupon failure in test sequence 3.3.2 shall necessitate the rejection of its corresponding serialized board. See information addenda for known problem areas.

4. QUALITY ASSURANCE PROVISIONS

4.1 GENERAL

In order to assure proper control of the acceptance process covered by this specification, the contractor shall meet all the requirements specified herein and shall provide continuous audit of the acceptance process to assure compliance with the requirements of this specification.

4.1.1 FLIGHT QUALIFICATED HARDWARE

A multilayer board is flight qualified when the board and coupon successfully completes the test sequence 3.3. with no failure in the board or the coupon.

4.1.2 INSPECTION

The contractor, through his quality assurance or control agency shall be responsible for the performance of all inspection requirements and tests specified herein.

4.2 FAILURE ANALYSIS

All weldable, multilayer circuit boards and coupons failing the sequence outlines in 3.3. shall be subjected to a failure analysis sufficient to identify cause of failure.

4.3 CONFORMANCE TO ND 1015404

Disclosure of any violation of previously agreed to contractor/supplier ND 1015404 critical process list without prior notification, automatically rejects the multilayer board. Notice of such deviation must be made by the contractor to MIE/IL within 24 hours of disclosure.

4.4 STORAGE

Coupons and sectioned holes of all boards classified as flight hardware shall be stored by lot number, SCD dash number and serial number for three years. The coupons must be readily accessible for future reference.

4.5 QUALIFICATION REPORT

Two copies of a report justifying the acceptance or rejection of the multilayer boards in a shipment lot shall be forwarded to MIL/IL prior to their use in deliverable end items. The report shall include the following:

4.5 (Cont'd)

a. The number of boards shipped in a shipment lot.

b. A list of the boards in the shipment lot identified by lot identification number, SCD 1006395 dash number and serial number which passed or failed flight qualification.

c. The failure analysis report of all boards or coupons which failed from test or were induced by the contractor indicating the exact cause of failure. Photograph should be included in the failure analysis report where possible.

5. NOTES

5.1 INTENDED USE

This process assesses boards used in Apollo G&N equipment by conditioning multilayer boards and the corresponding test coupons.

5.2 DEFINITIONS

5.2.1 SHIPMENT LOT

A shipment lot is any number of multilayer boards SCD 1006395 received by the contractor from one vendor in one day.

5.2.2 INDUCED FAILURES

An induced failure is a failure which through failure analysis can be proven to be caused by exceeding the stress limits of SCD 1006395. A board which has an induced failure cannot be used in flight equipment.

5.2.3 ELECTRICAL TEST FAILURES

a. Electrical Board Failure

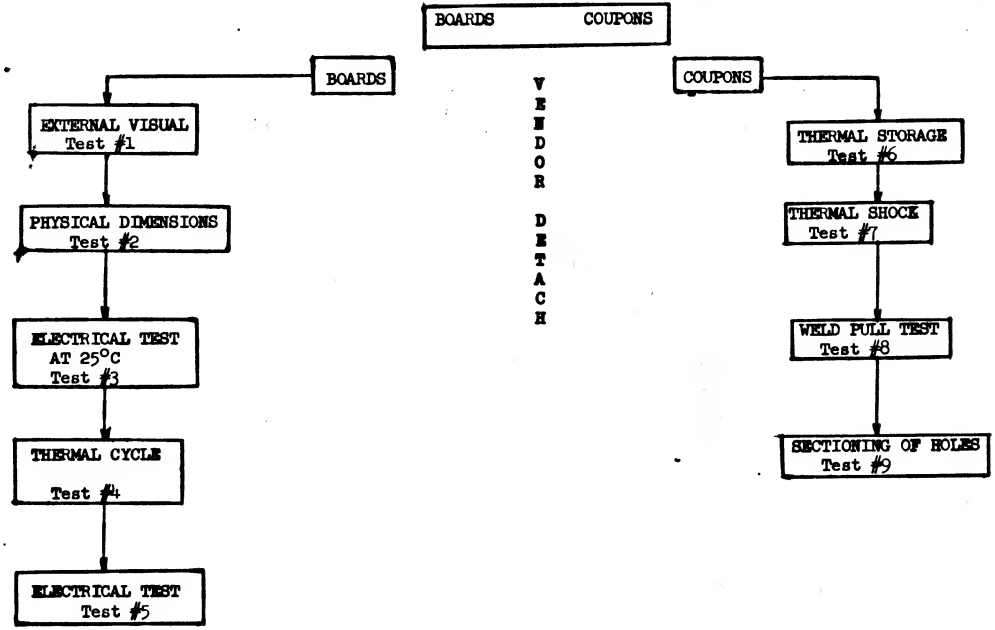
A failure at test #3 and #5 is the failure of any conducting path to be equal to or less than .3 ohms or the failure to maintain isolation resistance between conducting paths of 30 megohms at 100 VDC.

b. Electrical Coupon Failures

Electrical coupon failure is the failure of a test circuit to maintain continuity during tests #6 and #7 i.e., if flip-flop change of state is detected.

5.2.4 EXTERNAL VISUAL INSPECTION FAILURES

A failure at test #1 of paragraph 3.3 is a failure to meet the visual requirements of paragraph 3.3.4.1 and any additional requirements negotiated with the applicable vendor.



FLOW DIAGRAM OF TEST SEQUENCE 3.3.

Apollo Specification
ND 1002293
Original Issue Date:
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PROCESS SPECIFICATION SPECIAL CONDITIONING OF WELDABLE MULTILAYER CIRCUIT BOARDS

	DATE	REVISION	TDRR	PAGES REVISED	APPROVALS	
					MIT	NASA
(M)	3/15/66	A	27198	All Pages	FC	FC
	12/27	B	32521	4, 5	FC	FC

THIS SPECIFICATION CONSISTS OF PAGES 1 TO 8 INCLUSIVE.

APPROVALS			
	A. C. METZGER	EC Held 2/11/66	
	NASA/MSC	MIT/IL	RAYTHEON

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APPROVALS			
	A. C. METZGER	E C Hall 2/11/66	W Fiedler 11 Feb 66
	NASA/MSC	MIT/IL	RAYTHEON

3.3.4.8 (Cont'd)

1. An area which has a minimum plated thickness of .001 inches and a maximum length of .005 inches, provided it does not appear at the hole-conductor interface.

Sectioning of holes need not be performed in sequential order.

3.4 REMOVAL OF FAILURES

Boards which fail the test sequence 3.3.1 shall be removed at the completion of all tests. Any coupon failure in test sequence 3.3.2 shall necessitate the rejection of its corresponding serialized board. See information addenda for known problem areas.

4. QUALITY ASSURANCE PROVISIONS

4.1 GENERAL

In order to assure proper control of the acceptance process covered by this specification, the contractor shall meet all the requirements specified herein and shall provide continuous audit of the acceptance process to assure compliance with the requirements of this specification.

4.1.1 FLIGHT QUALIFICATED HARDWARE

A multilayer board is flight qualified when the board and coupon successfully completes the test sequence 3.3. with no failure in the board or the coupon.

4.1.2 INSPECTION

The contractor, through his quality assurance or control agency shall be responsible for the performance of all inspection requirements and tests specified herein.

4.2 FAILURE ANALYSIS

All weldable, multilayer circuit boards and coupons failing the sequence outlines in 3.3. shall be subjected to a failure analysis sufficient to identify cause of failure.

4.3 CONFORMANCE TO ND 1015404

Disclosure of any violation of previously agreed to contractor/supplier ND 1015404 critical process list without prior notification, automatically rejects the multilayer board. Notice of such deviation must be made by the contractor to MIT/IL within 24 hours of disclosure.

4.4 STORAGE

Coupons and sectioned holes of all boards classified as flight hardware shall be stored by lot number, SCD dash number and serial number for three years. The coupons must be readily accessible for future reference.

4.5 QUALIFICATION REPORT

Two copies of a report justifying the acceptance or rejection of the multilayer boards in a shipment lot shall be forwarded to MIL/IL prior to their use in deliverable end items. The report shall include the following:

3.3.4.8 (Cont'd)

1. An area which has a minimum plated thickness of .001 inches and a maximum length of .005 inches, provided it does not appear at the hole-conductor interface.

Sectioning of holes need not be performed in sequential order.

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4.4 STORAGE

Coupons and sectioned holes of all boards classified as flight hardware shall be stored by lot number, SCD dash number and serial number for three years. The coupons must be readily accessible for future reference.

4.5 QUALIFICATION REPORT

Two copies of a report justifying the acceptance or rejection of the multilayer boards in a shipment lot shall be forwarded to MIL/IL prior to their use in deliverable end items. The report shall include the following:

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PROCESS SPECIFICATION SPECIAL CONDITIONING OF WELDABLE MULTILAYER CIRCUIT BOARDS

	DATE	REVISION	TDRR	PAGES REVISED	APPROVALS	
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(M)	3/15/66	A	27198	All Pages	FG	E.E
(M)	12/27	B	32521	4, 5	FG	FG
(M)	6/6/68	C	36296	1,2,6,8,9	FG	FG

THIS SPECIFICATION CONSISTS OF PAGES 1 TO 9 INCLUSIVE.

APPROVALS	NASA/MSC		MIT/IL	RAYTHEON
	C. METZGER	2/11/66		11 Feb 66

3.2.1 LOT CONTROL - COUPON AND BOARD

A test coupon attached to each board during fabrication shall bear the same serial number as its respective board. The coupon, being simultaneously subjected to all processes, shall reflect the same standards of quality as the board and shall be indicative of all inherent features of the board encompassing circuit construction, circuit performance and overall quality. The coupon shall include test circuits as specified in SCD 1006395. Both the coupon and board shall be subjected to tests outlined in paragraph 3.3.

3.3 TEST PROCEDURE

3.3.1 TEST SEQUENCE FOR MULTILAYER BOARDS

All boards to be flight qualified shall be subjected to the following tests:

a. External visual (test #1).

b. Physical dimension (test #2).

c. Electrical test at 25°C (test #3)

d. Thermal cycle (test #4)

e. Electrical test at 25°C (test #5)

f. External Visual (Test #10)

3.3.2 TEST SEQUENCE FOR COUPON

All coupons as specified in SCD 1006395 shall be subjected to the following tests:

a. Thermal storage (test #6).

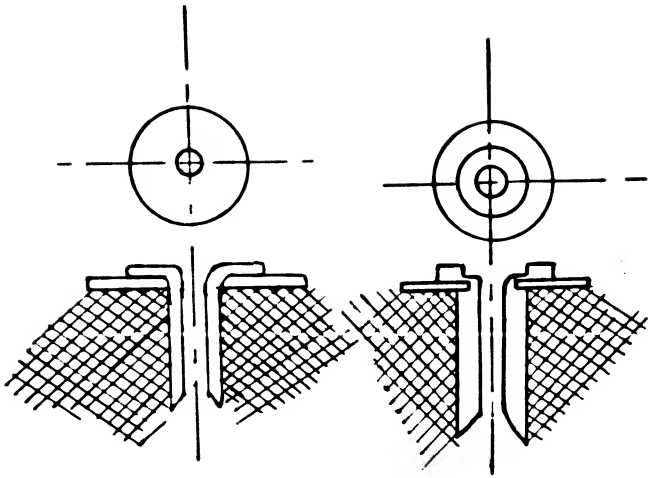
b. Thermal shock (test #7).

c. Weld pull test (test #8).

d. Sectioning of holes (test #9).

3.3.3 REMOVAL OF FAILURES

Coupons which fail shall be removed from the test sequence at the point of detection and subjected to failure analysis. Multilayer boards which fail shall complete the test sequence after which they shall be subjected to failure analysis. The location in the test sequence where failures occur must be recorded.



ACCEPTABLE

DIMPLE NOT ACCEPTABLE

FIGURE 1

Revised 7-4-66

Apollo Specification
ND 1002293
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Release Authority: TDRR
Class A Release 26210

PROCESS SPECIFICATION SPECIAL CONDITIONING OF WELDABLE MULTILAYER CIRCUIT BOARDS

DATE	REVISION	TDRR	PAGES REVISED	APPROVALS	
				MIT	NASA

THIS SPECIFICATION CONSISTS OF PAGES 1 TO 6 INCLUSIVE.

APPROVALS	A. C. METZGER NASA/MSC	E C Hall 2/4/66	W Rappler for Fallabe MIT/IL	W E Lamb for Fallabe RAYTHEON

PROCESS SPECIFICATION SPECIAL CONDITIONING OF WELDABLE MULTILAYER CIRCUIT BOARDS

1. SCOPE

1.1 PURPOSE

This specification establishes the minimum requirements for the acceptance of weldable, multilayer circuit boards for use in flyable deliverable end items. The procedures described herein shall be performed by the G&N industrial contractor as part of the incoming inspection.

2. APPLICABLE DOCUMENTS

2.1 EFFECTIVE ISSUES

The following documents of the issue in effect on the date of this document form a part of this specification to the extent described herein.

SPECIFICATIONS

MILITARY

MIL-STD-202	Test method for electronic and electrical component parts.
MIL-D-55110	Printed wiring boards.

DRAWINGS

Apollo G&N

1006390	Multilayer circuit board.

3. REQUIREMENTS

3.1 GENERAL

The provisions of this specification shall be applicable to all phases of acceptance of weldable multilayer circuit boards SCD 1006390 to the extent specified herein. Specification requirements or provisions not covered by this specification shall be as specified on the applicable drawing or purchase order. In the event of conflict between the requirements of the applicable drawings, this specification and other documents cited herein, the requirements of the applicable drawings and this specification shall govern in that order.

3.2 PROCESS CONTROL

The process covered by this specification shall be controlled in accordance with the provisions of Section 4, paragraph 4.2.

3.2.1 LOT CONTROL - COUPON AND BOARD

A test coupon shall be attached to each board and shall bear the same serial number of its respective board. The coupon, being simultaneously subjected to all processes, shall reflect the same standards of quality as the board and shall be indicative of all inherent features of the board encompassing circuit construction, circuit performance and overall quality. The coupon shall include test circuits as specified in SCD 1006390. Both the coupon and board shall be subjected to tests outlined in paragraph 3.3.

3.3. TEST PROCEDURE

Prior to the test sequence, the multilayer board shall be detached from the coupon. Care shall be taken to assure the quality of the board at the point of detachment leaving it free from delamination, chips, nicks, rough edges, cracking, crazing or exposed internal circuitry.

3.3.1 TEST SEQUENCE FOR MULTILAYER BOARDS

All boards to be flight qualified shall be subjected to the following tests:

a. External visual (test #1).

b. Physical dimension (test #2).

c. Thermal cycle (test #3).

d. Electrical test at 25°C (test #4).

3.3.2 TEST SEQUENCE FOR COUPON

All coupons as specified in SCD 1006390 shall be subjected to the following tests:

a. Thermal storage (test #5).

b. Thermal shock (test #6).

c. Weld pull test (test #7).

d. Sectioning of holes (test #8).

3.3.3 REMOVAL OF FAILURES

Coupons which fail shall be removed from the test sequence at the point of detection and subjected to failure analysis. Multilayer boards which fail shall complete the test sequence after which they shall be subjected to failure analysis. The location in the test sequence where failures occur must be recorded.

3.3.4 TEST

BOARD TESTS

3.3.4.1 EXTERNAL VISUAL (TEST #1)

All boards exhibiting the following shall be rejected.

a. Evidence of lifted circuitry.

b. Delamination or cracks leading to an edge.

c. Discrepancies

Blistering, wrinkes, crazing, delamination voids, resin-starvation within an area. 1/4" x 1/4" shall be limited to two per board and shall be spaced no closer than ,5 inch. Discrepancies exceeding an area 1/4" x 1/4" shall be rejected.

d. Internal conductors extending to edge of the board.

e. Contaminants on weld pads.

f. Evidence of intra-layer delamination.

g. Visual evidence of over or under etch condition of weld pads.

3.3.4.2 PHYSICAL DIMENSION (TEST #2)

All boards shall be inspected for configuration dimensions as specified in SCD 1006390. Flatness, warp or twist shall not exceed .090 ipch per board length.

3.3.4.3 THERMAL CYCLE (TEST #3)

All boards shall be cycled as follows:

Thermal storage at + 100°± 5°C 30 minutes minimum.

Thermal storage at - 15 ± 5°C 30 minutes minimum.

The above cycle shall be repeated twice.

3.3.4.4 ELECTRICAL TEST AT 25°C (TEST #4)

All boards shall be tested for circuit continuity and insulation resistance at 25 ± 2°C. These tests shall be performed on DITMCO or equivalent.

3.3.4.5 THERMAL STORAGE (TEST #5)

All coupons shall be subjected to the following, during which time provision shall be made to continuously monitor for all opens and intermittents (.25 microseconds).

a. Thermal storage at + 165 ± 5°C - 8 hours minimum.

b. Thermal storage at - 65 ± 5°C - 8 hours minimum.

3.3.4.6 THERMAL SHOCK (TEST #6)

Immediately following test 3.3.4.5 (thermal storage), all coupons shall be subjected to the following continuously monitored for all opens and intermittents (.25 microseconds).

Three cycles, 30 minute minimum residence at extremes of -65 ± 5°C and +165 ± 5°C. Transfer time between extremes shall not exceed 10 seconds.

3.3.4.7 WELD PULL TEST (TEST #7)

A weld pull test shall be performed on the pads of the coupon of SCD 1006390. A flat Kovar wire .012 in wide, .003 in thick with 50 to 100 microinches of gold shall be used for the pull tests. The pull test must meet the minimum isostrength of 3.6 pounds.

3.3.4.8 SECTIONING OF HOLES (TEST #8)

The plated through holes of the coupon specified in SCD 1006390 shall be sectioned and examined under 80 power minimum magnification for conformance to the following criteria:

The minimum plated copper thickness in the plated thru holes shall be .0015 inches over 75 percent of the cross-sectioned hole. The remaining 25 percent may exhibit a maximum of 3 of the following conditions on each side of a hole.

1. An area which has a minimum plated thickness of .0005 inches and a maximum length of .002 inches, provided it does not appear at the hole-conductor interface, and a similar condition does not appear on the adjacent side of the hole indicating a ring.

2. An area which has a minimum plated thickness of .001 inches and a maximum length of .005 inches, provided it does not appear at the hole-conductor interface.

3.4 REMOVAL OF FAILURES

Boards which fail the test sequence 3.3.1 shall be removed at the completion of all tests. Any coupon failure in test sequence 3.3.2 shall necessitate the rejection of its corresponding serialized board. See information addenda for known problem areas.

4. QUALITY ASSURANCE PROVISIONS

4.1 GENERAL

In order to assure proper control of the acceptance process covered by this specification, the contractor shall meet all the requirements specified herein and shall provide continuous audit of the acceptance process to assure compliance with the requirements of this specification.

4.1.1 FLIGHT QUALIFICATED HARDWARE

A multilayer board is flight qualified when the board and coupon successfully completes the test sequence 3.3. with no failure in the board or the coupon.

4.1.2 INSPECTION

The contractor, through his quality assurance or control agency shall be responsible for the performance of all inspection requirements and tests specified herein.

4.2 FAILURE ANALYSIS

All weldable, multilayer circuit boards and coupons failing the sequence outlines in 3.3. shall be subjected to a failure analysis sufficient to identify cause of failure.

4.3 CONFORMANCE TO ND 1015404

Disclosure of any violation of previously agreed to contractor/supplier ND 1015404 critical process list without prior notification, automatically rejects the multilayer board. Notice of such deviation must be made by the contractor to MIT/IL within 24 hours of disclosure.

4.4 STORAGE

Coupons and sectioned holes of all boards classified as flight hardware shall be stored by lot number, SCD dash number and serial number for three years. The coupons must be readily accessible for future reference.

4.5 QUALIFICATION REPORT

Two copies of a report justifying the acceptance or rejection of the multilayer boards in a shipment lot shall be forwarded to MIT/IL prior to their use in deliverable end items. The report shall include the following:

a. The number of boards shipped in a shipment lot.

b. A list of the boards in the shipment lot identified by lot identification number, SCD 1006390 dash number and serial number which passed or failed flight qualification.

c. The failure analysis report of all boards or coupons which failed from test or were induced by the contractor indicating the exact cause of failure. Photograph should be included in the failure analysis report where possible.

5. NOTES

5.1 INTENDED USE

This process assesses boards used in Apollo G&N equipment by conditioning multilayer boards and the corresponding test coupons.

5.2 DEFINITIONS

5.2.1 SHIPMENT LOT

A shipment lot is any number of multilayer boards SCD 1006390 received by the contractor from one vendor in one day.

5.2.2 INDUCED FAILURES

An induced failure is a failure which through failure analysis can be proven to be caused by exceeding the stress limits of SCD 1006390. A board which has an induced failure cannot be used in flight equipment.

5.2.3 EXTERNAL VISUAL INSPECTION FAILURES

A failure at test #1 of paragraph 3.3 is a failure to meet the visual requirements of paragraph 3.3.4.1 and any additional requirements negotiated with the applicable vendor.

5.2.4 ~~5.2.3~~ WELD TEST FAILURES

A weld test failure shall be where four successive good welds meeting the isostrength pull tests could not be performed and the problem as analyzed by Failure Analysis was attributable to the weldable laminate.

6. INFORMATION ADDENDA

a. Opens and intermittences at junction of conductor paths and plated thru holes due to epoxy smear. (Fig. 1a).

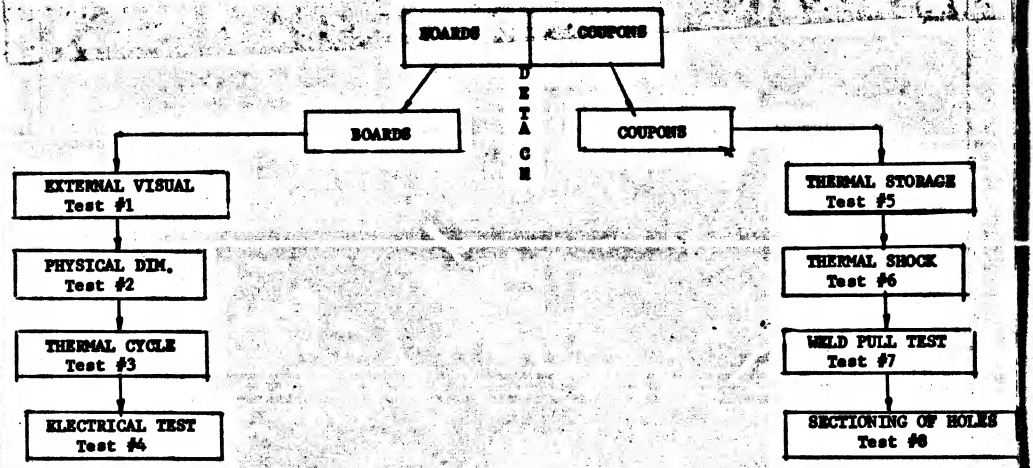
b. Opens and intermittences at junction of conductor paths and plated thru holes due to fracture at the junction. (Fig. 1b).

c. Shorting due to incomplete etching of conductor paths. (Fig. 1c).

d. Shorting due to conductive inclusions between conductor paths, pads or plated thru holes.(Fig. 1d).

e. Opens due to conductor breakdown caused by reduction of effective width.

f. Opens due to fracture of the plated thru hole "barrel crack".


BOARDS
COUPONS
DETACH
BOARDS
COUPONS
EXTERNAL VISUAL
Test #1
PHYSICAL DIM.
Test #2
THERMAL CYCLE
Test #3
ELECTRICAL TEST
Test #4
THERMAL STORAGE
Test #5
THERMAL SHOCK
Test #6
WELD PULL TEST
Test #7
SECTIONING OF HOLES
Test #8

APOLLO G&N Specification
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PROCESS FOR

ENCAPSULATING WITH SLOW REACTING POLYURETHANE FOAM

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals MIT	Approvals NASA
(M) 8/18/66	A	30657	1, 2, 3, 4, 5		

This specification consists of pages 1 to 5 inclusive.

APPROVALS	A. C. METZGER NASA/MSC	EC Hall for W6 Kluge and D Lewinson MIT/IL	A. Abrams for Jack W Fund	3/14/66 3/15/66 RAY 21 March 66

PROCESS FOR ENCAPSULATING WITH SLOW REACTING POLYURETHANE FOAM

1. SCOPE

1.1 This specification defines the procedure for encapsulation of Tray A, Tray B and DSKY, only, with a slow reacting polyurethane foam in order to protect the components from mechanical shock and vibration.

1.2 The foam system in this specification free foams to a density of 6 pounds nominal per cubic foot.

1.3 The low viscosity of the foam system and the fact that foaming will not commence up to four minutes after mixing at room temperature makes this system suitable for encapsulating large units having recesses otherwise difficult to reach for the conventional fast reacting polyurethane foams.

2. APPLICABLE DOCUMENTS

2.1 The following documents form a part of this specification to the extent specified herein.

SPECIFICATIONS

Federal

TT-M-261	Methyl - Ethyl - Ketone
BB-F-671	Freon T.F.

DRAWINGS

NASA

1006396	Resin, Urethane Foam
MD 1002004	Epoxy Bonding

3. REQUIREMENTS

3.1 Cleaning

3.1.1 Surfaces to be covered or contacted by the foam shall be clean and free of grease, oil, dirt, or other contamination which might adversely affect the adhesion of the foam. Use Freon T.F. or Ethyl Alcohol.

3.2 Mold Preparation

3.2.1 If used, tooling molds shall be cleaned by mechanical methods or chemically with solvent such as methyl - ethyl - ketone. After cleaning, the molds shall then be coated with a fluorocarbon base mold release agent which in no way shall have a deleterious affect on the resin system before, during, or after curing and which shall allow releasing cured foam from the mold surface without damage to the unit or foam.

3.3 Formulation of Materials

3.3.1 The following formulation of materials shall be used.

Resin Component per SCD 1006396-001	100 parts by wt
Curing Agent per SCD 1006396-002	90 parts by wt

3.4 AMOUNT OF FOAM REQUIRED

3.4.1 For free foam applications, the estimated weight of foam required shall be equal to the density in grams per cubic inch multiplied by the volume "V" in cubic inches or 1.58 x V grams.

NOTE: The free foam density of the foam is 6 pounds per cubic foot nominal which converts to 1.58 grams per cubic inch.

3.4.2 For closed mold applications, the maximum weight of foam required shall be equal to twice the weight required for free foam applications i.e. 3.16xV grams. The minimum weight required shall be the same as for free foam applications i.e. 1.58 V grams.

3.5 Mixing

3.5.1 Add the required amount of curing agent to resin component at 72° ± 5°F in the proportions specified in paragraph 3.3.1. Stir thoroughly by hand using a tongue depressor or equivalent for 30 ± 10 seconds.

NOTE: Do not machine mix because this will result in much quicker foaming action, which would make subsequent encapsulation difficult.

3.6 Encapsulating. A two stage filling is used to prevent the foam from seeping out at unsealed joints; i.e. around Malco pins.

NOTE: Preheating of the mold or unit shall not be allowed because this would result in a much quicker foaming action which would make subsequent encapsulation difficult.

3.6.1 First Stage

3.6.1 Using a syringe or equivalent, fill area around Malco pins with enough mixture for sealing as determined in 3.4.1.

3.6.1.2 Cure the mixture by allowing it to free foam at 175°F ± 5°F for 2 hours minimum.

3.6.1.3 Allow unit to cool to room temperature.

3.6.1.4 Any voids where Malco insulators are still visible are to be filled using this same free foam procedure.

3.6.2 Second Stage

3.6.2.1 Pour the required amount of mixture as determined in 3.4.2 into the remaining cavity, spreading the mixture uniformly over the entire area, and close the mold. The time available for pouring and closing the mold will be approximately 4 minutes from completion of stirring per par. 3.5.1

3.6.2.2 Cure the unit at 175°F ± 5°F for 2 hours minimum.

4. QUALITY ASSURANCE PROVISIONS

4.1 Visual inspection shall be performed using the naked eye.

4.2 The cured foam shall be rigid, non-tacky, and have the same size and shape as specified by the applicable drawing. Wiring may be visible but must be firmly imbedded in the cured foam. Wires which are visible must be coated with epoxy, .005 min. thk. per MD 1002004 Type V.

4.3 Voids permissible providing wiring is not exposed.

4.4 Qualification of materials. At the start of each 24 hour production period, a check of the materials shall be made regarding their ability to properly encapsulate. Either Test Method A or Test Method B shall be used as follows:

4.4.1 Test Method A. The materials shall be mixed as specified in paragraph 3.5.1. At least thirty five (35) grams shall be mixed. Twenty five (25) grams + 0 gram - 1 gram of the mixture shall be poured into an eight (8) ounce, wide mouth, jar. The mixture shall remain stationary and level until the foam has hardened (about 5 - 10 minutes). After the foam has hardened, the height of the foam shall be compared against the height of a standard, made in the same manner, from materials taken from freshly opened containers, newly received in-house. Such a standard shall be made for each lot of material. After the lot has been used up, the standard shall be discarded and a new one made for the next lot. The height of the sample shall be equal to the height of the standard with a tolerance of $^{+7\%}_{-15\%}$

4.4.2 Test Method B. Test specimens shall be prepared by combining the material at room temperature per paragraph 3.5.1 introducing 95 ± 5 grams of this material into a paper container (dixie cup #2186, 1 pint liquid) and allowing the sample to free blow and cure for a minimum of 1/2 hour. After the 1/2 hour cure is completed, a sample of foam shall be cut using the coring tool to a size convenient for measurement and examination. All skin shall be removed. The volume of this sample shall be a minimum of 1 -1/2 cubic inches. The resulting sample shall be measured to an accuracy of ± .005 inch and weighed to an accuracy of ± 0.1 grams. Density shall be calculated in pounds per cubic foot as follows: Density in grams/in^3 x 3.809 = Density in pounds/$ft.^3$. Density at room temperature shall be 6 lbs $^{+8\text{ ounces}}_{-16}$ /ft^3. The cured sample shall exhibit no excessive voids and shall have a cell structure, the foam surface shall be firm and tack free and shall not be friable.

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PROCESS FOR

ENCAPSULATING WITH SLOW REACTING POLYURETHANE FOAM

Record of Revisions

	Date	Revision Letter	TDRR No.	Pages Revised	Approvals MIT	Approvals NASA
(M)	8/18/66	A	30657	1, 2, 3, 4, 5		
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This specification consists of pages 1 to 6 inclusive.

APPROVALS	L. C. METZGER NASA/MSC	E C Hall 5/4/66 W G Hardy 5/4/66 Q Levenson MIT/IL	A Eberhard 3/4/66 3/5/66 RAY 21 Mar 66

3. REQUIREMENTS

3.1 Cleaning

3.1.1 Surfaces to be covered or contacted by the foam shall be clean and free of grease, oil, dirt, or other contamination which might adversely affect the adhesion of the foam. Use Freon T.F. or Ethyl Alcohol.

3.2 Mold Preparation

3.2.1 If used, tooling molds shall be cleaned by mechanical methods or chemically with solvent such as methyl - ethyl - ketone. After cleaning, the molds shall then be coated with a fluorocarbon base mold release agent which in no way shall have a deleterious affect on the resin system before, during, or after curing and which shall allow releasing cured foam from the mold surface without damage to the unit or foam.

3.2.2 The mold, assembly to be potted, and all associated tools (containers, & syringes, etc.) shall be kept in an environment in which the temperature is maintained at 81°F ± 6°F for a minimum of 4 hours prior to encapsulation.

3.3 Formulation of Materials

3.3.1 The following formulation of materials shall be used.

Resin Component per SCD 1006396-001	100 parts by wt
Curing Agent per SCD 1006396-002	90 parts by wt

3.4 AMOUNT OF FOAM REQUIRED

3.4.1 For free foam applications on DSKY, the estimated weight of foam required shall be equal to the density in grams per cubic inch multiplied by the volume "V" in cubic inches or 1.58 x V grams.

NOTE: The free foam density of the foam is 6 pounds per cubic foot nominal which converts to 1.58 grams per cubic inch.

3.4.2 For free foam applications on Tray A, the estimated weight of foam required shall be approximately equal to twice the density in GM/IN^3 multiplied by the volume V in IN^3 or 3.0 x V GM.

3.4.3 For free foam applications on Tray B, the estimated weight of foam required shall be equal to the volume in IN^3 multiplied by 2.0

3.4.4 For closed mold applications, the maximum weight of foam required shall be equal to twice the weight required for free foam applications i.e. 3.16xV grams. The minimum weight required shall be the same as for free foam applications i.e. 1.58 V grams.

3.5 Mixing

3.5.1 Add the required amount of curing agent to resin component at 81°F ± 6°F in the proportions specified in paragraph 3.3.1. Stir thoroughly by hand using a tongue depressor or equivalent for ± 10 seconds.

3.6 Encapsulating. A two stage filling is used to prevent the foam from seeping out at unsealed joints; i.e. around Malco pins.

3.6.1 First Stage

3.6.1 Using a syringe or equivalent, fill area around Malco pins with enough mixture for sealing as determined in 3.4.1.

3.6.1.2 Cure the mixture by allowing it to free foam at 175°F ± 5°F for 2 hours minimum. Application of mold covers is permitted to prevent over potting.

3.6.1.3 Allow unit to cool to 81°F ± 6°F.

3.6.1.4 Any voids where Malco insulators are still visible are to be filled using this same free foam procedure.

3.6.2 Second Stage

3.6.2.1 Pour the required amount of mixture as determined in 3.4.2 into the remaining cavity, spreading the mixture uniformly over the entire area, and close the mold. The time available for pouring and closing the mold will be approximately 4 minutes from completion of stirring per par. 3.5.1

3.6.2.2 Cure the unit at 175°F ± 5°F for 2 hours minimum.

4. QUALITY ASSURANCE PROVISIONS

4.1 Visual inspection shall be performed using the naked eye.

4.2 The cured foam shall be rigid, non-tacky, and have the same size and shape as specified by the applicable drawing. Wiring may be visible but must be firmly imbedded in the cured foam. Wires which are visible must be coated with epoxy, .005 min. thk. per ND 1002004 Type V.

4.3 Voids permissible providing wiring is not exposed.

4.4 Qualification of materials. At the start of each 24 hour production period, a check of the materials shall be made regarding their ability to properly encapsulate. Test Method A shall be used as follows:

4.4.1 Test Method A. The materials shall be mixed as specified in paragraph 3.5.1. All associated components (containers, jars, etc.) shall be kept in an environment in which the temperature is maintained at 81°F ± 6°F for a minimum of 4 hours prior to testing. At least thirty five (35) grams shall be mixed. Twenty five (25) grams +0 gram -1 gram of the mixture shall be poured into an eight (8) ounce, wide-mouth, glass jar within sixty (60) seconds after mixing has been completed. (The glass jar shall have nominal inside dimensions: 2.375" dia X 3.125" high). The mixture shall remain stationary and level until the foam has hardened (about 5-10 minutes). Care should be taken to set the glass jar on an insulating surface (foam pad) to reduce the transfer of heat through the glass. After the foam has hardened the dimension from the top of the foam crown to the top of the jar shall be measured. The resultant dimension shall fall within the range: 1.25" to 0.80".

4.4.2 Test Method B. Test specimens shall be prepared by combining the material per paragraph 3.5.1. All associated components (containers, etc.) shall be kept in an environment in which the temperature is maintained at 81°F ± 6°F for a minimum of 4 hours prior to testing. 95 ± 5 grams of this material shall be poured into a 1 pint round metal can approx. dim. 4" high x 3 1/4 dia. and allowed to free blow and cure for a minimum of 1/2 hour.

4.4.2 Test Method B. (Cont'd)

After the 1/2 hour cure is completed, a sample of foam shall be cut using the coring tool to a size convenient for measurement and examination. All skin shall be removed. The volume of this sample shall be a minimum of 1 -1/2 cubic inches. The resulting sample shall be measured to an accuracy of ± .005 inch and weighed to an accuracy of ± 0.1 grams. Density shall be calculated in pounds per cubic foot as follows: Density in grams/in^3 x 3.809 = Density in pounds/$ft.^3$. Density at room temperature shall be 6 lbs + 0 ounces - 16 /ft^3. The cured sample shall exhibit no excessive voids and shall have a cell structure, the foam surface shall be firm and tack free and shall not be friable.

4.4.3 If the sample does not meet the requirements of 4.4.1, the parant batch of materials used to make the sample shall not be used.

5. NOTES

5.1 Intended Use. The intent of potting or encapsulating computer trays with polyurethane foam is to provide a lightweight insulating material which will maintain the spatial relationship between components and wiring when such trays are subject to conditions of vibration, shock, and acceleration.

APOLLO G&N Specification
ND 1002295
Original Issue Date: 5-11-66
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Class Release

PROCESS FOR

ENCAPSULATING WITH SLOW REACTING POLYURETHANE FOAM

Record of Revisions

	Date	Revision Letter	TDRR No.	Pages Revised	Approvals MIT	Approvals NASA
M	8/18/66	A	30657	1, 2, 3, 4, 5	FA	FA
M	4/20/67	B	33644	1,3,4,5,6	FG	FG
M	8/17/67	C	34358	1, 3, 4, 5, 6	FG	FG

This specification consists of pages 1 to 6 inclusive.

APPROVALS	C. METZGER NASA/MSC	SC Hall 5/14/66 MIT/IL	A. Brenner 5/14/66 RAY 21 May 66

3. REQUIREMENTS

3.1 Cleaning

3.1.1 Surfaces to be covered or contacted by the foam shall be clean and free of grease, oil, dirt, or other contamination which might adversely affect the adhesion of the foam. Use Freon T.F. or Ethyl Alcohol.

3.2 Mold Preparation

3.2.1 If used, tooling molds shall be cleaned by mechanical methods or chemically with solvent such as methyl - ethyl - ketone. After cleaning, the molds shall then be coated with a fluorocarbon base mold release agent which in no way shall have a deleterious affect on the resin system before, during, or after curing and which shall allow releasing cured foam from the mold surface without damage to the unit or foam.

3.2.2 The mold, assembly to be potted, and all associated tools (containers, & syringes, etc.) shall be kept in an environment in which the temperature is maintained at 81 ^{o}F ± 6 ^{o}F for a minimum of 4 hours prior to encapsulation except as noted in Para 3.6.1.A and 3.6.2.A.

3.3 Formulation of Materials

3.3.1 The following formulation of materials shall be used.

Resin Component per SCD 1006396-001	100 parts by wt
Curing Agent per SCD 1006396-002	90 parts by wt

3.4 AMOUNT OF FOAM REQUIRED

3.4.1 For free foam applications on DSKY, the estimated weight of foam required shall be equal to the density in grams per cubic inch multiplied by the volume "V" in cubic inches or 1.58 x V IN.^{3}..

NOTE: The free foam density of the foam is 6 pounds per cubic foot nominal which converts to 1.58 grams per cubic inch.

3.4.2 For free foam applications on Tray A, the estimated weight of foam required shall be approximately equal to twice the density in GM/IN^3 multiplied by the volume V in IN^3 or 3.0 X V IN^3.

3.4.3 For free foam applications on Tray B, the estimated weight of foam required shall be equal to the volume in IN^3 multiplied by 2.0.

3.4.4 For closed mold applications, the maximum weight of foam required shall be equal to twice the weight required for free foam applications i.e. 3.16xV grams. The minimum weight required shall be the same as for free foam applications i.e. 1.58 V grams.

3.5 Mixing

3.5.1 Add the required amount of curing agent to resin component at 81°F ± 6°F in the proportions specified in paragraph 3.3.1. Stir thoroughly by hand using a tongue depressor or equivalent for 30 ± 10 seconds.

3.6 Encapsulating. A two stage filling is used to prevent the foam from seeping out at unsealed joints; i.e. around Malco pins.

3.6.1 First Stage

3.6.1.A The mold and the Assy to be potted may be preheated to 110°F max.

3.6.1.1 Using a syringe or equivalent, fill area around Malco pins with enough mixture for sealing as determined in 3.4.1, 3.4.2 or 3.4.3.

3.6.1.2 Cure the mixture by allowing it to free foam at 175°F ± 5°F for 2 hours minimum. Application of mold covers is permitted to prevent over potting.

3.6.1.3 Allow unit to cool to 75°F to 110°F.

3.6.1.4 Any voids where Malco insulators are still visible are to be filled using this same free foam procedure.

3.6.2 Second Stage

3.6.2.A The mold and the Assy to be potted may be preheated to 140°F max.

3.6.2.1 Pour the required amount of mixture as determined in 3.4.4 into the remaining cavity, spreading the mixture uniformly over the entire area, and close the mold. The time available for pouring and closing the mold will be approximately 4 minutes from completion of stirring per par. 3.5.1.

3.6.2.2 Cure the unit at 175°F ± 5°F for 2 hours minimum.

3.6.2.3 Any voids where wiring is exposed are to be filled per Para. 3.6.2.A, 3.6.2.1 & 3.6.2.2.

4. QUALITY ASSURANCE PROVISIONS

4.1 Visual inspection shall be performed using the naked eye.

4.2 The cured foam shall be rigid, non-tacky, and have the same size and shape as specified by the applicable drawing. Wiring may be visible but must be firmly imbedded in the cured foam. Wires which are visible must be coated with epoxy, .005 min. thk. per MD 1002004 Type V.

4.3 Voids permissible providing wiring is not exposed.

4.4 Qualification of materials. At the start of each 24 hour production period, a check of the materials shall be made regarding their ability to properly encapsulate. Test Method A shall be used as follows:

4.4.1 Test Method A. The materials shall be mixed as specified in paragraph 3.5.1. All associated components (containers, jars, etc.) shall be kept in an environment in which the temperature is maintained at 81°F ± 6°F for a minimum of 4 hours prior to testing. At least thirty five (35) grams shall be mixed. Twenty five (25) grams +0 gram -1 gram of the mixture shall be poured into an eight (8) ounce, wide-mouth, glass jar within sixty (60) seconds after mixing has been completed. (The glass jar shall have nominal inside dimensions: 2.375" dia X 3.125" high). The mixture shall remain stationary and level until the foam has hardened (about 5-10 minutes). Care should be taken to set the glass jar on an insulating surface (foam pad) to reduce the transfer of heat through the glass. After the foam has hardened the dimension from the top of the foam crown to the top of the jar shall be measured. The resultant dimension shall fall within the range: 1.25" to 0.80".

4.4.2 Test Method B. Test specimens shall be prepared by combining the material per paragraph 3.5.1. All associated components (containers, etc.) shall be kept in an environment in which the temperature is maintained at 81°F ± 6°F for a minimum of 4 hours prior to testing. 95 ± 5 grams of this material shall be poured into a 1 pint round metal can approx. dim. 4" high x 3 1/4 dia. and allowed to free blow and cure for a minimum of 1/2 hour.

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PROCESS FOR

ENCAPSULATING WITH SLOW REACTING POLYURETHANE FOAM

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA

This specification consists of pages 1 to 5 inclusive.

APPROVALS	A. C. METZGER NASA/MSC	EC Hall 5/14/66 MG Ellenby 5/14/66 D Lewerenz	MIT/IL	A. Hanneman 5/14/66 5/15/66 W P Lund RAY 21 May 66

PROCESS FOR ENCAPSULATING WITH SLOW REACTING POLYURETHANE FOAM

1. SCOPE

1.1 This specification defines the procedure for encapsulation of Tray A and Tray B (Dwgs 2003092 & 2003093) with a slow reacting polyurethane foam in order to protect the components from mechanical shock and vibration.

1.2 The foam system in this specification free foams to a density of 6 pounds per cubic foot.

1.3 The low viscosity of the foam system and the fact that foaming will not commence up to four minutes after mixing at room temperature makes this system suitable for encapsulating large units having recesses otherwise difficult to reach for the conventional fast reacting polyurethane foams.

2. APPLICABLE DOCUMENTS

2.1 The following documents form a part of this specification to the extent specified herein.

SPECIFICATIONS

Federal

TT-M-261	Methyl - Ethyl - Ketone
BB-F-671	Freon T.F.

DRAWINGS

NASA

1006396	Resin, Urethane Foam

3. REQUIREMENTS

3.1 Cleaning

3.1.1 Surfaces to be covered or contacted by the foam shall be clean and free of grease, oil, dirt, or other contamination which might adversely affect the adhesion of the foam. Use of Freon T.F. or other solvents which show no attack on the assembly may be used.

3.2 Mold Preparation

3.2.1 If used, tooling molds shall be cleaned by mechanical methods or chemically with solvent such as methyl - ethyl - ketone. After cleaning, the molds shall then be coated with a fluorocarbon base mold release agent which in no way shall have a deleterious affect on the resin system before, during, or after curing and which shall allow releasing cured foam from the mold surface without damage to the unit or foam.

3.3 Formulation of Materials

3.3.1 The following formulation of materials shall be used.

Resin Component per SCD 1006396-1	100 parts by wt
Curing Agent per SCD 1006396-2	90 parts by wt

3.4 AMOUNT OF FOAM REQUIRED

3.4.1 For free foam applications, the estimated weight of foam required shall be equal to the density in grams per cubic inch multiplied by the volume "V" in cubic inches or 1.58 x V grams.

NOTE: The free foam density of the foam is 6 pounds per cubic foot which converts to 1.58 grams per cubic inch.

3.4.2 For closed mold applications, the maximum weight of foam required shall be equal to twice the weight required for free foam applications i.e. 3.16xV grams. The minimum weight required shall be the same as for free foam applications i.e. 1.58 V grams.

3.5 Mixing

3.5.1 Add the required amount of curing agent to resin component at room temperature in the proportions specified in paragraph 3.3.1. Stir thoroughly by hand using a tongue depressor or equivalent for 30 $\pm$ 10 seconds.

NOTE: Do not machine mix because this will result in much quicker foaming action, which would make subsequent encapsulation difficult.

3.6 Encapsulating. A two stage filling is used to prevent the foam from seeping out at unsealed joints; i.e. around Malco pins.

NOTE: Preheating of the mold or unit shall not be allowed because this would result in a much quicker foaming action which would make subsequent encapsulation difficult.

3.6.1 First Stage

3.6.1.1 Using a syringe or equivalent, fill area around Malco pins with enough mixture for sealing as determined in 3.4.1.

3.6.1.2 Cure the mixture by allowing it to free foam at 175°F ± 5°F for 2 hours minimum.

3.6.1.3 Allow unit to cool to room temperature.

3.6.1.4 Any voids where Malco insulators are still visible are to be filled using this same free foam procedure.

3.6.2 Second Stage

3.6.2.1 Pour the required amount of mixture as determined in 3.4.2 into the remaining cavity, spreading the mixture uniformly over the entire area, and close the mold. The time available for pouring and closing the mold will be approximately 4 minutes from completion of stirring per par. 3.5.1.

3.6.2.2 Cure the unit at 175°F ± 5°F for 2 hours minimum.

4. QUALITY ASSURANCE PROVISIONS

4.1 Visual inspection shall be performed using the naked eye.

4.2 The cured foam shall be rigid, non-tacky, and have the same size and shape as specified by the applicable drawing.

4.3 The cured foam shall have a uniform cell structure. Skin surfaces shall have no voids or holes greater than .040" in length or width and .010" in depth. In addition, there shall be no more than 5 holes per square inch whose longest dimension is larger than .010".

4.4 Scratches

4.4.1 .005 inch depth maximum allowable.

4.4.2 .030 inch width maximum allowable.

4.4.3 1 inch length maximum allowable.

4.4.4 Not more than 2 scratches per square inch except those less than .005 inch depth and 1/2 inch length shall not be cause for rejection.

4.5 Qualification of materials. At the start of each 24 hour production period, a check of the materials shall be made regarding their ability to properly encapsulate. Either Test Method A or Test Method B shall be used as follows:

4.5.1 Test Method A. The materials shall be mixed as specified in paragraph 3.5.1. At least thirty five (35) grams shall be mixed. Twenty five (25) grams + 0 gram - 1 gram of the mixture shall be poured into an eight (8) ounce, wide mouth, jar. The mixture shall remain stationary and level until the foam has hardened (about 5 - 10 minutes). After the foam has hardened, the height of the foam shall be compared against the height of a standard, made in the same manner, from materials taken from freshly opened containers, newly received in-house. Such a standard shall be made for each lot of material. After the lot has been used up, the standard shall be discarded and a new one made for the next lot. The height of the sample shall be equal to the height of the standard with a tolerance of $^{+3\%}_{-10\%}$

4.5.2 Test Method B. Test specimens shall be prepared by combining the material at room temperature per paragraph 3.5.1 introducing 80 ± 5 grams of this material into a paper container with dimensions of 3 ± 1/2" diameter and 3 -1/4 inches minimum in height and allowing the sample to free blow and cure for a minimum of 1/2 hour. After the 1/2 hour cure is completed, a sample of the foam shall be cut using the coring tool to a size convenient for measurement and examination. All skin shall be removed. The volume of this sample shall be a minimum of 1 -1/2 cubic inches. The resulting sample shall be measured to an accuracy of ± .005 inch and weighed to an accuracy of ± 0.1 grams. Density shall be calculated in pounds per cubic foot as follows: Density in grams/in^3 x 3.809 = Density in pounds/$ft.^3$. Density at room temperature shall be 6 lbs $^{+10\text{ ounces}}_{-8}$ /ft^3. The cured sample shall exhibit no excessive voids and shall have a uniform cell structure, the foam surface shall be firm and tack free and shall not be friable.

4.5.3 If the sample does not meet the requirements of 4.8.1 or 4.8.2, whichever is used, the parent batch of materials used to make the sample shall not be used.

5. NOTES

5.1 Intended Use. The intent of potting or encapsulating computer trays with polyurethane foam is to provide a lightweight insulating material which will maintain the spatial relationship between components and wiring when such trays are subject to conditions of vibration, shock, and acceleration.

APOLLO 1002296

G & N SPECIFICATION

ND 1002296

TDRR NO. 28362

CLASS A RELEASE 27 Jan 166

SPECIFICATION

FOR

BLACK ANODIZING OF BERYLLIUM

Record of Revisions

Revision Letter	TDRR	Pages Revised	Approval MIT	Approval NASA	Date
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This specification consists of pages [redacted] 1 to 7 inclusive

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ND 1002296

PREPARED BY	ORGANIZATION	DATE
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APPROVED BY	ORGANIZATION	DATE

APOLLO

G & N SPECIFICATION

ND 1002296

SPECIFICATION FOR

BLACK ANODIZING OF BERYLLIUM

1. SCOPE

1.1 This specification covers the requirements for black anodizing beryllium to provide a corrosion resistant finish.

TYPE I DULL FINISH

TYPE II GLOSSY FINISH

TYPE III AS MACHINED FINISH

2. APPLICABLE DOCUMENTS

2.1 The following document, of the latest issue in effect on the date of invitation for bids, forms a part of this specification to the extent specified herein:

ND 1002125 Procurement Specification, Beryllium Shapes, Vacuum Hot Pressed

3. REQUIREMENTS

3.1 General Requirements

3.1.1 The black anodic coating covered by this specification shall be applied to beryllium metal that meets the requirements of ND 1002125.

3.1.2 Unless otherwise specified, the anodic coating shall be applied after all heat treatments and mechanical finishing operations, such as machining, brazing, forming, welding, etc.

3.1.3 Beryllium and its compounds are highly toxic. Adequate safety measures must be taken to protect against beryllium containing spray or solutions.

3.1.4 The smoothness and final optical characteristics of the anodic coating is dependent upon the surface finish of the part and the part shall be adequately prepared before the anodic coating is applied.

3.1.4.1 For Type I finishes, the anodic coating shall be applied to a dull surface finish on the beryllium yielding a matte dull black anodic finish. The dull surface finish on beryllium can be attained by immersion in a solution such as 40 per cent nitric acid, 2 per cent hydrofluoric acid (by volume) for 30 to 60 seconds. This treatment prior to anodic treatment results in a dull black coating of an egg shell texture. An alternate procedure is to vapor blast the surface using aluminum grit 25 microns approx. The resultant dimensional change shall meet the requirements of paragraph 3.3.1.

3.1.4.2 For Type II finishes the anodic coating shall be applied to a shiny bright beryllium surface yielding a glossy mirror like jet black anodic finish. The shiny bright finish on beryllium can be attained by immersion in a chemical polishing solution. A typical solution is:

Phosphoric acid (85 per cent)	100 gal
Sulfuric acid	5 1/2 gal
Water	23 gal
Chromic acid	115 lbs
Temperature	Ambient
Time	As required to meet requirements of paragraph 3.3.1

3.1.4.3 For Type III finishes the anodic coating shall be applied to the as machined beryllium surface. The resultant anodic finish may not be uniform and could vary from a dull to a shiny appearance.

3.1.5 When visually examined the beryllium part shall be free from all visible defects and foreign matter which will be detrimental to the appearance and performance of the anodic coating.

3.2 Materials

3.2.1 The anodizing solution shall be an aqueous chromic acid solution, having a chromic acid concentration of not less than 10% nor more than 35% by weight.

3.3 Detail Requirements

3.3.1 Unless otherwise specified, the thickness of the applied anodic coating shall be .0005 ± .0002 inch per surface, and the resultant dimensional loss shall not exceed 0.0001 inch per surface. For Type I and Type II coatings the additional dimensional loss due to surface preparation conforming to paragraph 3.1.4.1 and 3.1.4.2 shall not exceed 0.00005 inch per surface.

3.3.2 The applied anodic coating shall be capable of withstanding a temperature of 300°F without degradation or change of the color or surface condition of the anodic coating.

3.3.3 The anodic coating shall be continuous, smooth, and adherent. The uniformity of appearance (as noted in para. 3.1.4) is dependent upon the surface finish of the part. Visual examination shall disclose freedom from visible pits, porosity, powered areas and other defects. Suspect areas are to be examined under ten (10) power magnification to ensure freedom from defects.

3.3.4 The anodic coating shall be of such quality to protect the basic metal so that slight or no corrosion attack is found when articles or separate specimens are subjected to the Anodic Coating Corrosion Resistant Test. Appearance of corrosion on corners, edges, points of contact or at specimen marking shall not constitute cause of failure.

3.3.5 Areas which are not to be anodized are to be masked with a suitable masking material such as a chemical milling maskant. The maskant material shall be removed completely after anodic treatment and shall have no deleterious effects on the beryllium.

4 QUALITY ASSURANCE PROVISION

4.1 Test Specimens

4.1.1 Tests shall be performed either on the anodized beryllium parts or anodized beryllium test specimens. These test specimens shall be beryllium conforming to ND 1002125 and need not conform to the configuration of the end item, unless otherwise specified. The anodic coating on the anodized test specimens shall conform to all the detail requirements of paragraph 3.3.

4.2 Tests

4.2.1 Test specimens only shall be subjected to a temperature of 300° ± 10°F for a period of 4 hours. The color and luster of the anodic coating shall meet the requirements of paragraph 3.3.2.

4.2.2 Test specimens, treated as specified, shall be subjected to a 5% salt-spray test in accordance with Method 811.1 of Federal Test Method Standard No. 151 except that the significant surface should be inclined approximately 6° from the vertical. Specimens shall be exposed for 48 hours.

4.3 Inspection

4.3.1 Visual

4.3.1.1 The anodized parts and test specimens shall be visually inspected. Suspect areas are to be examined under ten (10) power magnification.

4.3.2 Dimensional

4.3.2.1 The dimensional change due to the anodic coating shall meet the requirements of paragraph 3.3.1.

4.3.2.2 Dimensional check of thickness of anodic coating is acceptable if performed on test specimen.

4.3.3 Finish

4.3.3.1 The anodized parts shall be inspected for compliance with surface finish, optical requirements and any other requirements specified on the drawing.

4.3.4 Corrosion Resistance

4.3.4.1 The anodized specimens shall be examined after salt spray exposure a and compared with unexposed specimens for the effects on corrosion to determine compliance with 3.3.4.

5. PREPARATION FOR DELIVERY

5.1 The anodized parts shall be packaged in accordance with ND 1002215, Code 5.

6. NOTES

6.1 The anodic coating is mainly BeO with some metallic beryllium. A typical spectrographic analysis indicates a minor amount of Chromium (1 to 10 percent) is present together with trace quantities (in the order of 0.001 per cent) of Fe, Ti, Si, Mg, and Al. The fact that the coating is black whereas BeO is normally white is believed to be due to the optical effect of the small particle size.

APOLLO 1002296

G & N SPECIFICATION

ND 1002296

TDRR NO. 28362

CLASS A RELEASE 27 April 66

SPECIFICATION

FOR

BLACK ANODIZING OF BERYLLIUM

Record of Revisions

Revision Letter	TDRR	Pages Revised	Approval MIT	Approval NASA	Date

This specification consists of pages [redacted] 1 to 6 inclusive

APOLLO

G & N SPECIFICATION

ND 1002296

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2

APOLLO

G & N SPECIFICATION

ND 1002296

SPECIFICATION FOR

BLACK ANODIZING OF BERYLLIUM

1. SCOPE

1.1 This specification covers the requirements for black anodizing beryllium to provide a corrosion resistant finish.

TYPE I DULL FINISH

TYPE II GLOSSY FINISH

TYPE III AS MACHINED FINISH

2. APPLICABLE DOCUMENTS

2.1 The following document, of the latest issue in effect on the date of invitation for bids, forms a part of this specification to the extent specified herein:

ND 1002125 Procurement Specification, Beryllium Shapes, Vacuum Hot Pressed

3. REQUIREMENTS

3.1 General Requirements

3.1.1 The black anodic coating covered by this specification shall be applied to beryllium metal that meets the requirements of ND 1002125.

3.1.2 Unless otherwise specified, the anodic coating shall be applied after all heat treatments and mechanical finishing operations, such as machining, brazing, forming, welding, etc.

3.1.3 Beryllium and its compounds are highly toxic. Adequate safety measures must be taken to protect against beryllium containing spray or solutions.

3.1.4 The smoothness and final optical characteristics of the anodic coating is dependent upon the surface finish of the part and the part shall be adequately prepared before the anodic coating is applied.

3.1.4.1 For Type I finishes,the anodic coating shall be applied to a dull surface finish on the beryllium yielding a matte dull black anodic finish. The dull surface finish on beryllium can be attained be immersion in a solution such as 40 per cent nitric acid, 2 per cent hydrofluoric acid (by volume) for 30 to 60 seconds. This treatment prior to anodic treatment results in a dull black coating of an egg shell texture.

3.1.4.2 For Type II finishes the anodic coating shall be applied to a shiny bright beryllium surface yielding a glossy mirror like jet black anodic finish. The shiny bright finish on beryllium can be attained by immersion in a chemical polishing solution. A typical solution is:

Phosphoric acid (85 per cent)	100 gal
Sulfuric acid	5 1/2 gal
Water	23 gal
Chromic acid	115 lbs
Temperature	Ambient
Time	As Required

3.1.4.3 For Type III finishes the anodic coating shall be applied to the as machined beryllium surface. The resultant anodic finish may not be uniform and could vary from a dull to a shiny appearance.

3.1.5 When visually examined the beryllium part shall be free from all visible defects and foreign matter which will be detrimental to the appearance and performance of the anodic coating.

3.2 Materials

3.2.1 The anodizing solution shall be an aqueous chromic acid solution, having a chromic acid concentration of not less than 10% nor more than 35% by weight.

3.3 Detail Requirements

3.3.1 Unless otherwise specified, the thickness of the applied anodic coating shall be .0005 ±.0002 inch per surface, and the resultant dimensional loss shall not exceed 0.0001 inch per surface.

3.3.2 The applied anodic coating shall be capable of withstanding a temperature of 300°F without degradation or change of the color or surface condition of the anodic coating.

3.3.3 The anodic coating shall be continuous, smooth, and adherent; The uniformity of appearance (as noted in pgh3.1.4) is dependent upon the surface finish of the part. Visual examination shall disclose freedom from visible pits, porosity, powdered areas and other defects. Suspect areas are to be examined under ten(10) power magnification to ensure freedom from defects.

3.3.4 The anodic coating shall be of such quality to protect the basic metal so that slight or no corrosion attack is found when articles or separate specimens are subjected to the Anodic Coating Corrosion Resistant Test. Appearance of corrosion on corners, edges, points of contact or at specimen marking shall not constitute cause of failure.

3.3.5 Areas which are not to be anodized are to be masked with a suitable masking material such as a chemical milling maskant. The maskant material shall be removed completly after anodic treatment and shall have no deleterious effects on the beryllium.

4. QUALITY ASSURANCE PROVISION

4.1 Test Specimens

4.1.1 Tests shall be performed either on the anodized beryllium parts or anodized beryllium test specimens. These specimens shall be beryllium from the same lot or pressing number as the fabricated parts, but need not conform to the configuration of the end item, unless otherwise specified. The anodic coating on the anodized test specimens shall conform to all the detail requirements of paragraph 3.3.

4.2 Tests

4.2.1 Test specimens only shall be subjected to a temperature of 300° ± 10°F for a period of 4 hours. The color and luster of the anodic coating shall meet the requirements of pgh3.3.2.

4.2.2 Test specimens, treated as specified, shall be subjected to a 5% salt-spray test in accordance with Method 811.1 of Federal Test Method Standard No. 151 except that the significant surface should be inclined approximately 6° from the vertical. Specimens shall be exposed for 48 hrs.

4.3 Inspection

4.3.1 Visual

4.3.1.1 The anodized parts and test specimens shall be visually inspected. Suspect areas are to be examined under ten (10) power magnification.

4.3.2 Dimensional

4.3.2.1 The dimensional change due to the anodic coating shall meet the requirements of paragraph 3.3.1.

4.3.2.2 Dimensional check of thickness of anodic coating is acceptable if performed on test specimens.

4.3.3 Finish

4.3.3.1 The anodized parts shall be inspected for compliance with surface finish, optical requirements and any other requirements specified on the drawing.

4.3.4 Corrosion Resistance

4.3.4.1 The anodized specimens shall be examined after salt spray exposure and compared with unexposed specimens for the effects on corrosion to determine compliance with 3.3.4.

5. Preparation for Delivery

5.1 The anodized parts shall be packaged in accordance with ND 1002215, Code 5.

6. Notes

6.1 The anodic coating is mainly BeO with some metallic beryllium. A typical spectrographic analysis indicates a minor amount of Chromium (1 to 10 per cent) is present together with trace quantities (in the order of 0.001 per cent) of Fe, Ti, Si, Mg, and Al. The fact that the coating is black whereas BeO is normally white is believed to be due to the optical effect of the small particle size.

APOLLO G&N Specification
ND1002299 REV - A
Original Issue Date: 16 Feb 67
Release Authority: TDRR 32797
Class A Release

GFP RETEST SPECIFICATION

FOR

BLOCK II POWER AND SERVO ASSEMBLIES

DRAWING NO. 2007200

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals AC	Approvals NASA
4/6/67	A	33534	2 PCN-1	MGM EA	-

This specification consists of page 1 to 8 inclusive.

APPROVALS	NASA/MSC	W Stameris 14 Feb 67 MIT/IL	R Kraemer AC	D P Lattenbeyer AC

APOLLO G&N Specification
ND1002299 REV - B
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GFP RETEST SPECIFICATION

FOR

BLOCK II POWER AND SERVO ASSEMBLIES

DRAWING NO. 2007200

Record of Revisions

	Date	Revision Letter	TDRR No.	Pages Revised	Approvals AC	Approvals NASA
(M)	4/6/67	A	33534	2 KOG/MC	MGM EA	-
(M)	5/11/67	B	33791	4, 7 JH/AC	MGM EA	-

This specification consists of page 1 to 8 inclusive.

APPROVALS	NASA/MSC	W Stameris 14 Feb 67 MIT/IL	R Kraemer AC

4. QUALITY ASSURANCE PROVISIONS

5.1 GENERAL. Testing of the PSA shall consist of Recertification Testing or Minimum Retests but not both. Additional testing may be specified by the ARRO.

4.2 RECERTIFICATION TESTING. Unless otherwise specified by the ARRO, the PSA shall be subjected to testing as follows:

a. When the Header Assembly (Drawing 2007093) is replaced by one that has not been subjected to the Workmanship-Vibration test, all tests specified in Specification PS2007200 shall be performed.

b. When the Header Assembly is not replaced, or replaced by one that has been subjected to the Workmanship-Vibration test, all tests specified in Specification PS2007200, except the Workmanship-Vibration test, shall be performed.

4.3 MINIMUM RETEST. The PSA shall be subjected to the applicable test(s) listed in Table I only when Minimum Retest is specified by the ARRO. Figure 1 may be used as a reference to locate the specified modules.

5. PREPARATION FOR DELIVERY

5.1 GENERAL. Preparation for delivery shall be in accordance with Specification ND1002214.

6. NOTES. None.

JD:mw

2/1/67

APOLLO G&N Specification
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GFP RETEST SPECIFICATION

FOR

BLOCK II POWER AND SERVO ASSEMBLIES

DRAWING NO. 2007200

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA

This specification consists of page 1 to 8 inclusive.

APPROVALS	NASA/MSC	W Stameris 14 Feb 67 MIT/IL	R Kraemer	ACSP

1. SCOPE

1.1 PURPOSE. This specification establishes the test requirements for repaired GFP Block II Power and Servo Assemblies, hereafter called the PSA, which have been returned for repair or replacement of nonconforming subassemblies.

1.2 DEVIATIONS. Deviations from the requirements of this specification are permitted without waivers only as specified in the Apollo Repair Retest Order (ARRO) and as authorized by NASA/RASPO.

2. APPLICABLE DOCUMENTS

2.1 EFFECTIVE ISSUES. The following documents form a part of this specification to the extent specified herein.

SPECIFICATIONS

APOLLO G&N

ND1002214	General Specification for Preservation, Packaging, Packing and Container Marking of APOLLO Guidance and Navigation Major Assemblies, Assemblies, Subassemblies, Parts and Associated Ground Support Equipment
PS2007200	Procurement Specification, Product Configuration and Acceptance Test Requirements, Power and Servo Assembly, Drawing No. 2007200

DRAWINGS

APOLLO G&N

2007093	Header Assembly PSA (C/M)

4. QUALITY ASSURANCE PROVISIONS

4.1 GENERAL. Testing of the PSA shall consist of Recertification Testing or Minimum Retests but not both. Additional testing may be specified by the ARRO.

4.2 RECERTIFICATION TESTING. Unless otherwise specified by the ARRO, the PSA shall be subjected to testing as follows:

a. When the Header Assembly (Drawing 2007093) is replaced, all tests specified in Specification PS2007200 shall be performed.

b. When the Header Assembly is not replaced, all tests specified in Specification PS2007200, except the Workmanship-Vibration test, shall be performed.

4.3 MINIMUM RETEST. The PSA shall be subjected to the applicable test(s) listed in Table I only when Minimum Retest is specified by the ARRO. Figure 1 may be used as a reference to locate the specified modules.

5. PREPARATION FOR DELIVERY

5.1 GENERAL. Preparation for delivery shall be in accordance with Specification ND1002214.

6. NOTES. None.

TABLE I (Cont.)

REPLACED MODULE	APPLICABLE TEST PARAGRAPH IN SPECIFICATION PS2007200
2007123 Optics Relay Module (J12)	4.3.18.6, 4.3.19.1, 4.3.19.7, 4.3.20.1, 4.3.22, 4.3.2 (Table II, 45J7-D5 to 45J4-C15 and 45J7-D5 to 45J4-B15
2007123 Optics Relay Module (J13)	4.3.19.1, 4.3.19.2, 4.3.19.3, 4.3.19.4, 4.3.19.7, 4.3.19.8, 4.3.19.9, 4.3.20.1, 4.3.20.2, 4.3.20.3, 4.3.20.4, 4.3.20.7
2007123 Optics Relay Module (J14)	4.3.18.1, 4.3.18.3, 4.3.18.4, 4.3.18.6, 4.3.19.10, 4.3.20.9
2007093 Header Assembly	All tests in PS2007200

APOLLO G&N Specification
ND1002300 REV A
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GFP RETEST SPECIFICATION

FOR

LEM POWER AND SERVO ASSEMBLIES

DRAWING NO. 6007200

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Date	Revision Letter	TDRR No.	Pages Revised	Approvals AC	Approvals NASA
4/6/67	A	33534	2 (DR/AC)	MGM EA	-

This specification consists of page 1 to 6 inclusive.

APPROVALS	NASA/MSC	W Stameris 14 Feb 67 MIT/IL	R Kraemer AC

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GFP RETEST SPECIFICATION

FOR

LEM POWER AND SERVO ASSEMBLIES

DRAWING NO. 6007200

Record of Revisions

	Date	Revision Letter	TDRR No.	Pages Revised	Approvals AC	Approvals NASA
(M)	4/6/67	A	33534	2 RDL/AC	MGM EA	-
	5/11/67	B	33792	4, 5 JH/AC	MGM EA	-

This specification consists of page 1 to 6 inclusive.

APPROVALS	NASA/MSC	MIT/IL	AC
		W Hamerich 14 Feb 67	R Kraemer

4. QUALITY ASSURANCE PROVISIONS

4.1 GENERAL. Testing of the PSA shall consist of Recertification Testing or Minimum Retests but not both. Additional testing may be specified by the ARRO.

4.2 RECERTIFICATION TFSTING. Unless otherwise specified by the ARRO, the PSA shall be subjected to testing as follows:

a. When the Header Assembly (Drawing 6007003) is replaced by one that has not been subjected to the Workmanship-Vibration test, all tests specified in Specification PS6007200 shall be performed.

b. When the Header Assembly is not replaced, or replaced by one that has been subjected to the Workmanship-Vibration test, all tests specified in Specification PS6007200, except the Workmanship-Vibration test, shall be performed.

4.3 MINIMUM RETEST. The PSA shall be subjected to the applicable test(s) listed in Table I only when Minimum Retest is specified by the ARRO. Figure 1 may be used as a reference to locate the specified modules.

5. PREPARATION FOR DELIVERY

5.1 GENERAL. Preparation for delivery shall be in accordance with Specification ND1002214.

6. NOTES. None.

2/1/67

APOLLO G&N Specification
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LEM POWER AND SERVO ASSEMBLIES

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				MIT	NASA

This specification consists of page 1 to 6 inclusive.

APPROVALS	NASA/MSC	W Stameris 14 Feb 67 MIT/IL	R Kraemer ACSP

4. QUALITY ASSURANCE PROVISIONS

4.1 GENERAL. Testing of the PSA shall consist of Recertification Testing or Minimum Retests but not both. Additional testing may be specified by the ARRO.

4.2 RECERTIFICATION TESTING. Unless otherwise specified by the ARRO, the PSA shall be subjected to testing as follows:

a. When the Header Assembly (Drawing 6007003) is replaced, all tests specified in Specification PS6007200 shall be performed.

b. When the Header Assembly is not replaced, all tests specified in Specification PS6007200, except the Workmanship-Vibration test, shall be performed.

4.3 MINIMUM RETEST. The PSA shall be subjected to the applicable test(s) listed in Table I only when Minimum Retest is specified by the ARRO. Figure 1 may be used as a reference to locate the specified modules.

5. PREPARATION FOR DELIVERY

5.1 GENERAL. Preparation for delivery shall be in accordance with Specification ND1002214.

6. NOTES. None.

TABLE I

MINIMUM RETEST REQUIREMENT

REPLACED MODULE	APPLICABLE TEST PARAGRAPH IN SPECIFICATION PS6007200
6007114 G&N Subsystem Supply Filter	4.3.3, 4.3.4.b(3)
2007109 AAC Filter & MV, 3200 cps	4.3.4
2007108 Amplifier, 3200 cps, 1%	4.3.4
2007112 AAC Filter & MV, 800 cps	4.3.5a(1); 4.3.5.b(1), (2); 4.3.5.c(1)
2007110 Amplifier, 800 cps, 1%	4.3.5.a(1); 4.3.5.b(1), (2); 4.3.5.c(1)
2007111 Amplifier, 800 cps, 5%, ØA	4.3.5.a(1), (2), (3); 4.3.5.b(1), (2), (3); 4.3.5.c(1), (2), (3)
2007111 Amplifier, 800 cps, 5%, ØB	4.3.5 (all)
2007132 IMU Load Comp Module	4.3.5.a, 4.3.5.c
2007114 IG Gimbal Servo Amplifier	4.3.8.1; 4.3.8.2.a, b, c; 4.3.8.3; 4.3.8.4; 4.3.2
2007114 MG Gimbal Servo Amplifier	4.3.9.1; 4.3.9.2.a, b, c; 4.3.9.3; 4.3.9.4; 4.3.2
2007114 OG Gimbal Servo Amplifier	4.3.10.1; 4.3.10.2.a, b, c; 4.3.10.3; 4.3.10.4; 4.3.2
2007123 Relay Module	4.3.8.2.a, b, c; 4.3.8.3; 4.3.8.4; 4.3.9.2.a, b, c; 4.3.9.3; 4.3.9.4; 4.3.10.2.a, b, c; 4.3.10.3; 4.3.10.4; 4.3.2 (Table I, 45J19-A21 to 45J19-B21, 45J19-B8 to 45J19-B7)
2007117 IMU Auxiliary Module	4.3.2 (Table I, 45J19-A21 to 45J19-B21, 45J19-B8 to 45J19-B7); 4.3.7; 4.3.8.2.d, e, f; 4.3.9.2.d, e, f; 4.3.10.2.d, e, f; 4.3.11
2007107 -28 VDC Power Supply	4.3.6
6007003 Header Assembly	All tests in PS6007200

2/1/67

APOLLO G&N Specification
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GFP RETEST SPECIFICATION

FOR

SERIES 100 POWER AND SERVO ASSEMBLIES

DRAWING NO. 1007570

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA

This specification consists of page 1 to 12 inclusive.

APPROVALS	NASA/MSC	W Stameris 14 Feb 67 MIT/IL	R Kraemer	ACSP

1. SCOPE

1.1 PURPOSE. This specification establishes the test requirements for repaired GFP Series 100 Power and Servo Assemblies, hereafter called the PSA, which have been returned for repair or replacement of nonconforming subassemblies.

1.2 DEVIATIONS. Deviations from the requirements of this specification are permitted without waivers only as specified in the Apollo Repair Retest Order (ARRO) and as authorized by NASA/RASPO.

2. APPLICABLE DOCUMENTS

2.1 EFFECTIVE ISSUES. The following documents form a part of this specification to the extent specified herein.

SPECIFICATIONS

APOLLO G&N

ND1002214	General Specification for Preservation, Packaging, Packing and Container Marking of APOLLO Guidance and Navigation Major Assemblies, Assemblies, Subassemblies, Parts and Associated Ground Support Equipment
ATP1007570	Assembly Test Procedure for the Power and Servo Assembly

2/3/67

APOLLO G&N Specification
ND1002304 REV -
Original Issue Date: 2 MAR 67
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Class A Release
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GFP RETEST SPECIFICATION

FOR

INERTIAL MEASURING UNIT ASSEMBLIES (SERIES 90 AND 100)

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA

This specification consists of page 1 to 7 inclusive.

APPROVALS						
	R.L.K./MSC	Robert Crisp 2-24-67	MIT/IL	G.S.A.	P. Temple 2/24/67	ACSB

4. QUALITY ASSURANCE PROVISIONS

4.1 GENERAL. Testing of the IMU shall consist of Recertification Testing or Minimum Retests, but not both. Additional testing may be specified by the ARRO.

4.2 RECERTIFICATION TESTING. Unless otherwise specified by the ARRO, the IMU shall be subjected to all of the following JDC's. An asterisk following the JDC number in this list indicates that the JDC is for removal, installation, or assembly and shall be performed as required prior to, or subsequent to, performing tests specified in the other JDC's.

JDC09198*	JDC09865
JDC09200*	JDC11339
JDC09206*	JDC11340
JDC09207*	JDC20002
JDC09208*	JDC20003
JDC09209*	JDC20004
JDC09210*	JDC20005
JDC09211*	JDC20006
JDC09212*	JDC20007
JDC09213	JDC20008
JDC09854	JDC11379
JDC09855	JDC20011
JDC09856	JDC20013
JDC09861	JDC20014

4.3 MINIMUM RETEST. The IMU shall be tested as indicated in Table I only when Minimum Retest is specified by the ARRO.

5. PREPARATION FOR DELIVERY. Preparation for delivery shall be in accordance with Specification ND1002214.

6. NOTES

6.1 JDC CROSS REFERENCE. The following cross reference of JDC's by number and title is provided for reference only.

Number	Title
09022	Continuity and DC Resistance Test
09197	Heat Exchanger Leak Test
09198	IRIG Installation Procedure
09199	Continuity Test
09200	PIP Installation Procedure
09202	Heater Control Calibration
09206	Assembly of Middle Gimbal
09207	Assembly of Outer Gimbal
09208	Assembly of Connector Mounts
09209	Assembly of Case Cover
09210	Removal of Case Cover

2/1/67

APOLLO G&N Specification
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GFP RETEST SPECIFICATION

FOR

SIGNAL CONDITIONER ASSEMBLY

C/M FLIGHT-QUAL

(DRAWING NO. 2007235)

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA

This specification consists of page 1 to 5 inclusive.

APPROVALS	NASA/MSC	MIT/IL	ACSP
		R M Kowalski 14 Feb 67	J M Potenski 13 January 1967

2/1/67

APOLLO G&N Specification
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GFP RETEST SPECIFICATION

FOR

SIGNAL CONDITIONER ASSEMBLY

C/M FLIGHT-QUAL

(DRAWING NO. 2007235)

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA

This specification consists of page 1 to 5 inclusive.

APPROVALS	NASA/MSC	R M Kowalski 14 Feb 67	MIT/IL	J M Sistanski 13 January 1967	ACSP

1. SCOPE

1.1 PURPOSE. This specification establishes the test requirements for repaired GFP Signal Conditioner Assemblies C/M Flight-Qual, hereafter called the SCA, which have been returned for repair or replacement of nonconforming subassemblies.

1.2 DEVIATIONS. - Deviations from the requirements of this specification are permitted without waivers only as specified in the Apollo Repair Retest Order (ARRO) and as authorized by NASA/RASPO.

2. APPLICABLE DOCUMENTS

2.1 EFFECTIVE ISSUES. The following documents form a part of this specification to the extent specified herein.

SPECIFICATIONS

APOLLO G&N

ND1002214	General Specification for Preservation, Packaging, Packing and Container Marking of APOLLO Guidance and Navigation Major Assemblies, Assemblies, Sub-assemblies, Parts and Associated Ground Support Equipment
PS2007235	Procurement Specification, Product Configuration and Acceptance Test Requirements, Signal Conditioner Assembly C/M Flight Qual, Drawing No. 2007235

DRAWINGS

APOLLO G&N

2007271	Header Assembly Signal Conditioner, C/M Flight-Qual

All boiler plate

1. SCOPE

1.1 PURPOSE. This specification establishes the test requirements for repaired GFP Signal Conditioner Assemblies C/M Flight-Qual, hereafter called the SCA, which have been returned for repair or replacement of nonconforming subassemblies.

1.2 DEVIATIONS. - Deviations from the requirements of this specification are permitted without waivers only as specified in the Apollo Repair Retest Order (ARRO) and as authorized by NASA/RASPO.

2. APPLICABLE DOCUMENTS

2.1 EFFECTIVE ISSUES. The following documents form a part of this specification to the extent specified herein.

SPECIFICATIONS

APOLLO G&N

ND1002214	General Specification for Preservation, Packaging, Packing and Container Marking of APOLLO Guidance and Navigation Major Assemblies, Assemblies, Subassemblies, Parts and Associated Ground Support Equipment
PS2007235	Procurement Specification, Product Configuration and Acceptance Test Requirements, Signal Conditioner Assembly C/M Flight Qual, Drawing No. 2007235

DRAWINGS

APOLLO G&N

2007271	Header Assembly Signal Conditioner, C/M Flight-Qual

Add boiler plate

3. REQUIREMENTS

3.1 TEST CONDITIONS. Test conditions for the SCA shall be as specified in PS2007235.

3.2 REPLACEMENT SUBASSEMBLIES. Only subassemblies that have met the requirements of their applicable procurement specifications shall be used as replacement subassemblies.

3.3 PRECAUTIONS. The situations which led to the repair or replacement of a nonconforming subassembly may also have induced a malfunction in other subassemblies. Before proceeding with retest of the SCA, detailed investigation is required regarding the proper operation of all subassemblies which interact with the nonconforming unit.

4. QUALITY ASSURANCE PROVISIONS

4.1 GENERAL. Testing of the SCA shall consist of Recertification Testing or Minimum Retests, but not both. Additional testing may be specified by the ARRO.

4.2 RECERTIFICATION TESTING. Unless otherwise specified by the ARRO, the SCA shall be subjected to testing as follows:

a. When the Header Assembly (Drawing 2007271) is replaced, all tests specified in Specification PS2007235 shall be performed.

b. When the Header Assembly is not replaced, all tests specified in Specification PS2007235, except the Workmanship-Vibration test, shall be performed.

4.3 MINIMUM RETEST. The SCA shall be subjected to the applicable test(s) listed in Table I only when Minimum Retest is specified by the ARRO. Figure 1 may be used as a reference to locate the specified modules.

TABLE I

TEST SELECTION

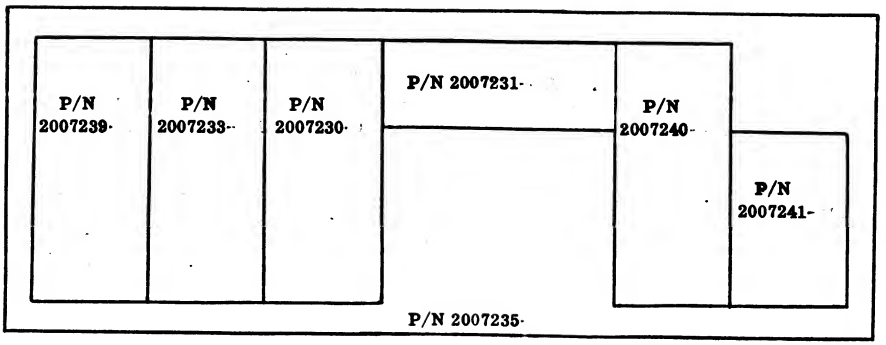
REPLACED COMPONENT	APPLICABLE TEST PARAGRAPH IN SPECIFICATION PS2007235
Gimbal Resolver (Dwg No. 2007230)	4.3.4, 4.3.5, 4.3.12 (Assembly sections A1 through A6 only)
PIPA and IRIG (Dwg No. 2007231)	4.3.4, 4.3.5, 4.3.12 (Assembly sections B1, B2, B3, B5, B6, and B7 only)
DAC, PIPA Temp and 2.5V Bias (Dwg No. 2007233)	4.3.4, 4.3.5, 4.3.12 (All assembly sections except D5, D6, and D11)
Torque Motor & 1X Sine Gimbal Resolvers (Dwg No. 2007239)	4.3.4, 4.3.5, 4.3.12 (All assembly D sections)
Optics and Attitude Error (Dwg No. 2007240)	4.3.4, 4.3.5, 4.3.12 (Assembly sections E1 through E6 only)
120V PIPA Sup. IRIG Temp. (Dwg No. 2007241)	4.3.4, 4.3.5, 4.3.12 (Assembly sections F1 and F2 only)
Header Assembly (Dwg No. 2007271)	Complete Specification PS2007235

5. PREPARATION FOR DELIVERY

5.1 GENERAL. Preparation for delivery shall be in accordance with paragraph 4.3.1 of Specification PS2007235 and Specification ND1002214.

6. NOTES. None.

JD/jls



MODULE LOCATION, C/M FLIGHT QUAL SCA

FIGURE 1

2/1/67

APOLLO G&N Specification
ND1002310 REV –
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GFP RETEST SPECIFICATION

FOR

SIGNAL CONDITIONER ASSEMBLY

LEM FLIGHT-QUAL

DRAWING NO. 6007010

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				MIT	NASA

This specification consists of page 1 to 6 inclusive.

APPROVALS	NASA/MSC	R M Koweski 14 Feb 67	MIT/IL	CCB	13 January 1967 ACSD

1. SCOPE

1.1 PURPOSE. This specification establishes the test requirements for repaired GFP LEM Flight-Qual Signal Conditioner Assemblies, hereafter called the SCA, which have been returned for repair or replacement of nonconforming subassemblies.

1.2 DEVIATIONS. Deviations from the requirements of this specification are permitted without waivers only as specified in the Apollo Repair Retest Order (ARRO) and as authorized by NASA/RASPO.

2. APPLICABLE DOCUMENTS

2.1 EFFECTIVE ISSUES. The following documents form a part of this specification to the extent specified herein.

SPECIFICATIONS

APOLLO G&N

ND1002214	General Specification for Preservation, Packaging, Packing and Container Marking of APOLLO Guidance and Navigation Major Assemblies, Assemblies, Subassemblies, Parts and Associated Ground Support Equipment
PS6007010	Procurement Specification, Product Configuration and Acceptance Test Requirements, Signal Conditioner Assembly, LEM Flight-Qual, Drawing 6007010

DRAWINGS

APOLLO G&N

6007016	Header Assembly, Signal Conditioner, LEM Flight Qual

Add boiler plate

1. SCOPE

1.1 PURPOSE. This specification establishes the test requirements for repaired GFP LEM Flight-Qual Signal Conditioner Assemblies, hereafter called the SCA, which have been returned for repair or replacement of nonconforming subassemblies.

1.2 DEVIATIONS. Deviations from the requirements of this specification are permitted without waivers only as specified in the Apollo Repair Retest Order (ARRO) and as authorized by NASA/RASPO.

2. APPLICABLE DOCUMENTS

2.1 EFFECTIVE ISSUES. The following documents form a part of this specification to the extent specified herein.

SPECIFICATIONS

APOLLO G&N

ND1002214	General Specification for Preservation, Packaging, Packing and Container Marking of APOLLO Guidance and Navigation Major Assemblies, Assemblies, Subassemblies, Parts and Associated Ground Support Equipment
PS6007010	Procurement Specification, Product Configuration and Acceptance Test Requirements, Signal Conditioner Assembly, LEM Flight-Qual, Drawing 6007010

DRAWINGS

APOLLO G&N

6007016	Header Assembly, Signal Conditioner, LEM Flight Qual

Add boiler plate

3. REQUIREMENTS

3.1 TEST CONDITIONS. Test conditons for the SCA shall be as specified in Specification PS6007010.

3.2 REPLACEMENT SUBASSEMBLIES. Only subassemblies that have met the requirements of their applicable procurement specifications shall be used as replacement subassemblies.

3.3 PRECAUTIONS. The sitautions which led to the repair or replacement of a nonconforming subassembly may also have induced a malfunction in other subassemblies. Before proceeding withretest of the SCA, detailed investigation is required regarding the proper operation of all subassemblies which interact with the nonconforming unit.

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4. QUALITY ASSURANCE PROVISIONS

4.1 GENERAL. Testing of the SCA shall consist of Recertification Testing or Minimum Retests, but not both. Additional testing may be specified by the ARRO.

4.2 RECERTIFICATION TESTING. Unless otherwise specified by the ARRO, the SCA shall be subjected to testing as follows:

a. When the Header Assembly (Drawing 6007016) is replaced, all tests specified in Specification PS6007010 shall be performed.

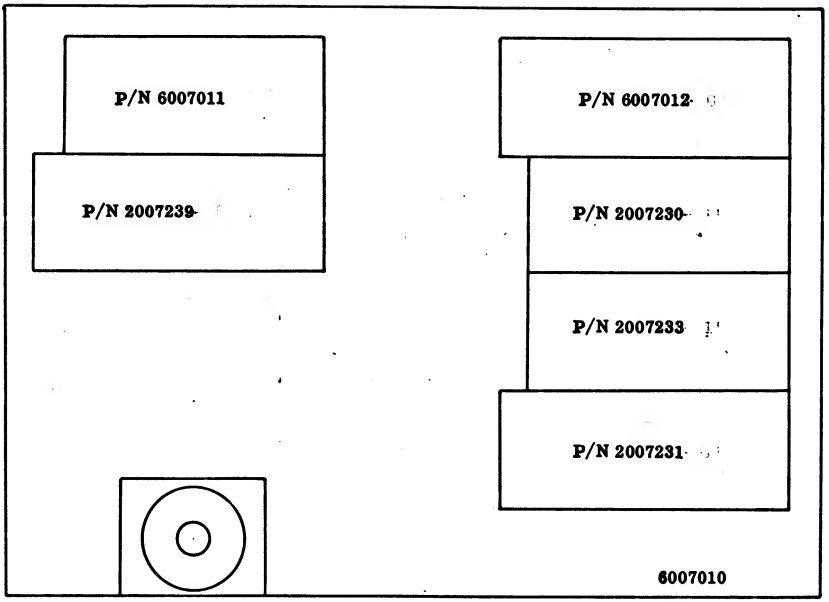
b. When the Header Assembly is not replaced, all tests specified in Specification PS6007010, except the Workmanship-Vibration test, shall be performed.

4.3 MINIMUM RETEST. The SCA shall be subjected to the applicable test(s) listed in Table I only when Minimum Retest is specified by the ARRO. Figure 1 may be used as a reference to locate the specified modules.

TABLE I

TEST SELECTION

REPLACED/REPAIRED COMPONENT	APPLICABLE TEST PARAGRAPH IN SPECIFICATION PS6007010
Gimbal Resolver (Dwg No. 2007230)	4.3.4, 4.3.5, 4.3.13 (Assembly sections A1 through A6 only)
PIPA and IRIG (Dwg No. 2007231)	4.3.4, 4.3.5, 4.3.13 (Assembly sections B1, B2, B3, B5, B6, and B7 only)
DAC, PIPA Temp and 2.5V Bias (Dwg No. 2007233)	4.3.4, 4.3.5, 4.3.13 (All Assembly sections except D7, D8, F1, F2, and F3
Torque Motor and 1X Sine Gimbal Resolver (Dwg No. 2007239)	4.3.4, 4.3.5, 4.3.13 (All assembly D sections, assembly sections F1, F2, & F3)
ISS CDU Fine Errors (Dwg No. 6007011)	4.3.4, 4.3.5, 4.3.13, (Assembly section F1 through F5 only)
Radar Resolvers and 120V PIPA Supply (Dwg No. 6007012)	4.3.4, 4.3.5, 4.3.11, 4.3.13 (Assembly sections E1 through E5 only)
Header Assembly (Dwg No. 6007016)	Complete PS6007010



MODULE LOCATION, LEM FLIGHT QUAL SCA

FIGURE 5

5. PREPARATION FOR DELIVERY

5.1 GENERAL. Preparation for delivery shall be in accordance with paragraph 4.3.1 of Specification PS6007010 and Specification ND1002214.

6. NOTES. None.

JD:jls

Apollo G&N Specification
ND 1002313 Rev. A
Original Issue Date:
Release Authority: TDRR 32567
Class A Release

PROCESS SPECIFICATION
SPECIAL CONDITIONING OF TRANSISTORS

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approval	
				MIT	NASA
5 JAN 67	A	32567	Initial Release		

This specification consists of pages 1 to 14 inclusive.

APPROVALS	NASA	MIT/IL	RAYTHEON
		E C Hall 9 Dec 66 W Stameris 7 Dec 66	

3.3.1.d Removal of Failures

Catastrophic failures only shall be removed from the test sequence at the point of detection and subjected to failure analysis. The point in the test sequence 3.3.1 where the failure was detected must be recorded and a set of electrical readings as specified in Paragraph 3.3.2.3 shall be performed. All electrical failures at the end of the test sequence 3.3.1 shall be subjected to failure analysis except the incoming marginal failures as defined in 6.2.3 (a), may be returned to the vendor. All non-catastrophic failures shall remain in the test until completion of (n) test #13 in test sequence 3.3.1. All failures at (t) test #18 shall be removed from use but not subjected to failure analysis.

3.3.2 Tests

3.3.2.1 External Visual Inspection

Each lot of transistors shall be subjected to an external visual inspection in accordance with MIL-STD-750, method 2071.

3.3.2.2 Physical Dimension, Lead Tension & Fatigue

A minimum of 3 samples of transistors shall be subjected to the physical dimension examination of MIL-STD-750, method 2066. The units shall be subjected to the lead tension and lead fatigue tests in accordance with MIL-STD-750 method 2036 conditions A and E and to the requirements of the specification control drawings. The units subjected to the lead tension and lead fatigue tests are to be forwarded to test #17 of the test sequence 3.3.1.

3.3.2.3 Electrical Test (Test #3 of 3.3.1)

The entire lot except the devices in 3.3.2.2 shall be subjected to the following tests in the given order:

a) Collector-emitter saturation voltage at 150 ma
b) DC current gain at 10 ma
c) DC current gain at 150 ma
d) Emitter-base breakdown voltage
Collector-emitter threshold current
Collector-emitter breakdown voltage
Collector-emitter sustaining voltage
Base-emitter saturation voltage at 500 ma

Turn-on, turn-off time is to be performed on a sample basis to a .65% AQL to the limits and conditions specified in Specification Control Drawing 1006323.

3.3.2.4 Electrical Test (Test #9, #13, #16 and #18 of 3.3.1)

The entire lot except the devices used in 3.3.2.2 shall be subjected to

voltage applied at a temperature of 25° ± 5°C for a period of 72 ± 8 hours.

3.3.2.12 Gain Measurement (Test #11)

DC Current gain at 10ma as defined in Specification Control Drawing 1006323, shall be measured.

3.3.2.13 Internal Visual Inspection

The internal visual inspection shall be performed on the 25 units from test #16, paragraph 3.3.2.15 and 3 samples from test #2, paragraph 3.3.2.2.

3.3.2.14 Vibration Test

The vibration test shall be performed on a random sample of 25 units. The vibration test shall be performed in accordance with MIL-STD-750, Method 2056, 30 g's from 5' to 2000 cps limited to 0.12 inch double amplitude, 3 cycles, 15 minutes per cycle minimum.

3.3.2.15 Shock Test

The shock test shall be performed on the same units tested in 3.3.2.14 The shock test shall be performed in accordance with MIL-STD-750, Method 2016, 1500 g's, 0.5 msec, 5 blows in all axis directions, 30 blows total.

3.3.2.16 Encapsulation [illegible]

All transistors shall be encapsulated per paragraph 3.1.1.3.1 or shall be [illegible].

3.3.2.17 [illegible]

The electrical test shall be the same as [illegible] except that the AT higher tan[illegible], 7% lower than the minimum shall not apply.

4. QUALITY ASSURANCE PROVISIONS

4.1 GENERAL

In order to assure proper control of the acceptance process covered by this specification, the contractor shall meet all the requirements specified herein and shall provide continuous audit of the acceptance process to assure compliance with the requirements of this specification.

4.1.1 Inspection

The contractor, through his quality assurance or control agency shall be responsible for the performance of all inspection requirements and test specified herein.

4.2 FAILURE CRITERIA

4.2.1 Failure Analysis

All transistors failing in the electrical tests specified in

3.3.2 (Test #3, #9, #11, #13, and #16) except the noncatastrophic failures as defined in 6.2.3 (a), and (c)) shall be subjected to a failure analysis sufficient to identify cause and mode of failure. For failure definitions refer to section 6.2.

4.2.2 Failure Mode Groupings ...uires

After failure analysis, all failures detected at test #3, #9, #11, and #13 of test sequence 3.3.1, except induced failures shall be grouped as described below and the percentage failure for the lot in each group shall be determined.

Group 0 - Test #3

Non-catastrophic failures as defined in 6.2.3 (a) and switching time failures.

GROUP I

1. Open bonds due to poor metal adhesion to silicon or silicon dioxide.
2. Open bonds due to underbonding (insufficient pressure and/or temperature).
3. Open bonds due to overbonding (excessive pressure and/or temperature) exclusive of thinning of lead wires of ultrasonic or wedge bonding.
4. Opens in lead wires due to nicks, cuts or crimps in lead wires.
5. Opens due to chip becoming detached from the header.
6. Collector to emitter shorting and/or opening of leads due to the $V_{CEO(Sust)}$ test or secondary breakdown at first electrical test.
7. Failures due to cracked chip.
8. Non-catastrophic failures due to surface instabilities.
9. Emitter-to-base shorts detected at first electrical test due to bonds making contact to each other.
10. Shorts, intermittent or otherwise, detected at first electrical test due to free lead material or fixed extra leads designed into the device.
11. Open bonds detected at first electrical test due to formation of intermetallic compounds of aluminum and gold.

GROUP II

1. Leads shorting to the surface or edge of the chip, to the can or header, or to each other due to excessive lead length.
2. Leads shorting to the chip because of insufficient post height.
3. Shorting after first electrical test due to secondary breakdown detected because of a device fault.
4. Catastrophic failures due to surface instabilities.
5. Shorts through the silicon dioxide due to poor oxide dielectric strength.
6. Shorts, intermittent or otherwise, due to particles in the package.
7. Shorts, intermittent or otherwise, due to free lead material or fixed extra leads or lead material.

NOTE: If the leads were designed into the device and the short was not detected at first electrical test, the failure falls into this category.

8. Open bonds detected after first electrical test due to formations of intermetallic compounds of aluminum and gold.

9. Emitter to base shorting detected after first electrical test due to bonds making contact to each other.

10. Open bonds for any cause detected after first electrical test where a substance has been put over the bonds and this substance was the only means of making electrical contact.

11. Opens due to excessive thinning of lead wires at the base of the bond.

GROUP III

1. Any failures, except induced failures, not listed above or any failures for an unknown cause.

TABLE I

Test Number (See Para. 3.3.1)	*MAXIMUM PERCENTAGE OF FAILURES			
	Group 0	Group I	Group II	Group III
3	2%	1.0%	0.5%	0
9 & 13		0.5%	0.2%	0

*If the number of unit failures allowable is calculated to be a mixed number, a combination of an integer, and a fraction, use the integer only.

TABLE II

Test Number (See Paragraph 3.3.1)		
Lead bend and fatigue	#2	1 defective
Dimension	#2	1 defective
Leak Test	#5	2%
Leak Test	#6	2%
Gain Measurement	#11	1 defective
Internal Visual	#17	2 defective
Electrical Test	#16	1 defective

4.3 REJECTION CRITERIA

4.3.1 Lot Rejection

The failures of a shipment lot shall be classified as specified in 4.4.2 such that the failures can be identified with the groupings specified in 4.4.3. The maximum allowable percentages of failures from test number 3, 9, and 11 of paragraph 3.3.1 according to the failure mode groupings of 4.2.3 are given in Table I. The maximum allowable percentage of failures from test numbers 2, 5, 6, 11, 16, and 17 of paragraph 3.3.1 are given in Table II where the failure definitions are given in 6.2. Failure to meet any one of the maximum allowable percentages of table I and II, failure to meet the A.Q.L. of the sampling test, or failure to comply with the test sequence of 3.3.1 the test procedures 3.3.2, the flight qualification requirements of 4.4, or the data requirements of 4.5 shall be cause for lot rejection.

4.3.1.1 Conformance to ND 1015404

Disclosure of any violation of previously agreed to contractor-supplier ND 1015404 "Critical Process" list without prior notification automatically fails the entire lot. Notice of such deviation must be made by the contractor to MIT/IL within 24 hours of disclosure.

4.4 FLIGHT QUALIFICATION

4.4.1 Flight Qualified Hardware

A transistor is flight qualified when the lot, of which the transistor is part, is not rejected according to 4.3.1 and the transistor does not fail any test of the test sequence of paragraph 3.3.1. Lots that failed the criteria of this specification cannot be resubmitted for flight qualification without waiver. Failures occurring after encapsulation shall not affect the flight qualification criteria of the lot.

4.4.1.1 Failure Traceability

Any transistor failure detected in qualified flight hardware must be traceable to a lot as identified in paragraph 3.2.1.

4.4.2 Qualification Report

Two copies of a report justifying the acceptance or rejection of a lot as flight qualified shall be forwarded to MIT/IL prior to use in deliverable end items. The report shall include the following:

a. A copy of the summary of the supplier's Quality Demonstration test.

b. A summary of screen and burn-in data and a detailed list of the screen and burn-in results which includes the number of failures during test sequence 3.3.1.

c. A failure report of all electrical failures, by unit serial number including induced failures, as specified in 4.2.1 which includes:

 c1. Photographs of each category of each photographable failure. A minimum of two photographs for each category is required where more than one exists.

6.2 DEFINITIONS

6.2.1 Lot

A lot is defined as a group of transistors submitted by a vendor in compliance with 1006323. All serialized units of each lot must be identifiable to that lot.

6.2.2 Catastrophic Failures

A catastrophic failure is defined as any device which fails the electrical tests by twice the maximum or one half the minimum limits as specified in Table II of SCD 1006323.

6.2.3 Non-Catastrophic Failures

Non-catastrophic failure is any device which cannot be classed as a catastrophic failure by definition 6.2.2 but which fails according to the definitions described below:

a. A non-catastrophic failure at test 3.3.2.3 exceeds the limits of Table II of Specification Control Drawing 1006323 and does not become a catastrophic failure during test sequence 3.3.1.

b. A non-catastrophic failure at test 3.3.2.4 exceeds the limits described in 3.3.2.4 but does not become a catastrophic failure (6.2.2).

c. A non-catastrophic failure at test 3.3.2.12 exceeded a change in DC current gain by ± 20% in test sequence 3.3.1 test #9 and test #11.

6.2.4 Induced Failures

An induced failure is a catastrophic failure which through failure analysis can be proven to be caused by exceeding the stress limits of Specification Control Drawing 1006323.

6.2.5 Leak Test Failures

A failure at test #5 or #6 of paragraph 3.3.1 is failure to meet the leak test limits as specified in Specification Control Drawing 1006323, and failure criteria of MIL-STD-202C, method 112, test condition A.

6.2.6 External Visual Inspection Failures

A failure at test #1 of paragraph 3.3.1 is a failure to meet the visual and mechanical examination criteria of Specification Control Drawing 1006323.

6.2.7 Physical Dimension Failures

The physical dimension failures of test #2 of paragraph 3.3.1 is a package which does not meet the physical dimension criteria of specification control drawing 1006323.

Apollo G&N Specification
ND 1002313 Rev. B
Original Issue Date:
Release Authority: TDRR 32567
Class A Release

PROCESS SPECIFICATION
SPECIAL CONDITIONING OF TRANSISTORS

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approval MIT	Approval NASA
(M) 5 SEP 67	A	32567	Initial Release	Gadt	
(M) 7-13-67	B	34126	1, 7, 8	dhd/FC	dhd FC

This specification consists of pages 1 to 14 inclusive.

APPROVALS	NASA	MIT/IL	RAYTHEON
		E C Hall 7 Dec 66 W Stameris 7 Dec 66	

3.3.2 (Test #3, #9, #11, #13, and #16) except the non-catastrophic failures as defined in 6.2.3 (a), and (c) shall be subjected to a failure analysis sufficient to identify cause and mode of failure. For failure definitions refer to section 6.2.

4.2.2 Failure Mode Groupings

After failure analysis, all failures detected at test #3, #9, #11, and #13 of test sequence 3.3.1, except induced failures shall be grouped as described below and the percentage failure for the lot in each group shall be determined.

Group 0 - Test #3

Non-catastrophic failures as defined in 6.2.3 (a) and switching time failures.

GROUP I

1. Open bonds due to poor metal adhesion to silicon or silicon dioxide.
2. Open bonds due to underbonding (insufficient pressure and/or temperature).
3. Open bonds due to overbonding (excessive pressure and/or temperature) exclusive of thinning of lead wires of ultrasonic or wedge bonding.
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5. Opens due to chip becoming detached from the header.
6. Collector to emitter shorting and/or opening of leads due to the V_{CEO} (Sust) test or secondary breakdown at first electrical test.
7. Failures due to cracked chip.
8. Non-catastrophic failures due to surface and/or bulk instabilities.
9. Emitter-to-base shorts detected at first electrical test due to bonds making contact to each other, lead material shorting across metalization, or excessive metallization.
10. Shorts, intermittent or otherwise, detected at first electrical test due to free lead material or fixed extra leads designed into the device.
11. Open bonds detected at first electrical test due to formation of intermetallic compounds of aluminum and gold.

GROUP II

1. Leads shorting to the surface or edge of the chip, to the can or header or to each other due to excessive lead length.
2. Leads shorting to the chip because of insufficient post height.
3. Shorting after first electrical test due to secondary breakdown detected because of a device fault.
4. Catastrophic failures due to surface and/or bulk instabilities.
5. Shorts through the silicon dioxide due to poor oxide dielectric strength.
6. Shorts, intermittent or otherwise, due to particles in the package.
7. Shorts, intermittent or otherwise, due to free lead material or fixed extra leads or lead material.

NOTE: If the leads were designed into the device and the short was not detected at first electrical test, the failure falls into this category.

8. Open bonds detected after first electrical test due to formations of intermetallic compounds of aluminum and gold.

9. Emitter to base shorting detected after first electrical test due to bonds making contact to each other, lead material shorting across metalization, or excessive metalization.

10. Open bonds for any cause detected after first electrical test where a substance has been put over the bonds and this substance was the only means of making electrical contact.

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GROUP III

1. Any failures, except induced failures, not listed above or any failures for an unknown cause.

TABLE I

Test Number (See Para. 3.3.1)	*MAXIMUM PERCENTAGE OF FAILURES			
	Group 0	Group I	Group II	Group III
3	2%	1.0%	0.5%	0
9 & 13		0.5%	0.2%	0

*If the number of unit failures allowable is calculated to be a mixed number, a combination of an integer, and a fraction, use the integer only.

TABLE II

Test Number (See Paragraph 3.3.1)		
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Leak Test	#6	2%
Gain Measurement	#11	1 defective
Internal Visual	#17	2 defective
Electrical Test	#16	1 defective

APOLLO G&N Specification
ND1002315 REV A
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Release Authority: TDRR 30860
Class A Release

PROCESS SPECIFICATION

LAMINATING PHENOLIC IMPREGNATED GLASS CLOTH

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				AC	NASA
8/30/66	A	30860	1-11	JP	--

This specification consists of page 1 to 11 inclusive.

APPROVALS	NASA/MSC		
	W. B. [illegible] 8/31/66	J. F. Poggiali 9-30-66	J. Pagliaro for R. L. Heppler 8/31/66

1. SCOPE

1.1 PURPOSE. This specification covers the process for the fabrication and inspection of solid phenolic impregnated glass fiber cloth parts.

1.2 CLASSIFICATION. The requirements for the process covered by this specification shall be designated as ND1002315-001.

2. APPLICABLE DOCUMENTS

2.1 EFFECTIVE ISSUES. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, Military Standards and Specifications shall be the issue in effect on the date of request for proposal or invitation to bid.

SPECIFICATIONS

Federal

TT-I-735	Isopropyl Alcohol
O-T-634, Type II	Trichloroethylene, Stabilized
TT-M-00261	Methyl Ethyl Ketone: For Use In Organic Coatings

DRAWINGS

APOLLO G&N

1008907	Phenolic Resin-Glass Cloth Laminating Material
1008904	Epoxy-Phenolic Glass-Supported Film Adhesive

STANDARDS

Federal Test Method

406	Plastics, Organic, General Specification Test Method

(Copies of specifications, standards, drawings, bulletins, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 SPECIAL MATERIALS AND EQUIPMENT

3.1.1 Parting Agents

3.1.1.1 Wax. "Lusterless" No. 1738, Liquid or Paste, S. C. Johnson & Son, Inc.

3.1.2 Dope-Cellulose Acetate.

3.1.3 Silicone Resin. R-671, Dow Corning Company.

3.2 PARTING FILM. Cellophane, 300 MAT-2, E. I. DuPont De Nemours, Incorporated.

3.3 SPIKED ROLLER. Any suitable shop perforating tool with spikes approximately 0.050 inch in diameter and spaced approximately 1/2 inch apart.

3.4 MOLD BLEEDER MATERIAL

3.4.1 Canvas. Commercial Grade.

3.4.2 Glass Cloth. Commercial Grade.

3.4.3 Wood Fiber Mat. Tufflex, 1/2 inch thick UX200 (Fire Retardant), Wood Conversion Company.

3.5 BAG SEALING MATERIALS

3.5.1 Masking Tape. No. 200, Minnesota Mining and Manufacturing Company..

3.5.2 Double-Coated Masking Tape #401. Minnesota Mining and Manufacturing Company.

3.5.3 Sealing Compound. No. 5110, Schnee-Morehead Polymer Corporation or No. 57916 Presstite, Presstite Division, American Marietta Company.

3.6 BAG MATERIALS

3.6.1 Polyvinyl Chloride or Polyvinyl Alcohol Film. Reynolon 0.003 and 0.006 inch film, Reynolds Metal Company.

3.6.2 Mylar. 0.003 inch film, E. I. DuPont De Nemours Incorporated.

3.7 "RIP" STRIP MATERIALS

a. Unimpregnated 181 or 143 Glass Cloth
b. Impregnated 181 or 143 Glass Cloth

NOTE: The cloth shall be impregnated with the same resin system that is used in the lay-up.

3.8 GLOVES. White cotton, commercial grade.

3.9 EQUIPMENT

a. Heat Iron, Model TF Thermosealer, Wells Mfg. Company
b. Hot Air Blower, Model 12300, Master Appliance Company

3.10 MOLDS. Molds may be either male or female, metallic or non-metallic or any combination. If basically porous materials are used, they shall be so treated to be impervious to air at curing temperatures and pressures. The mold material surface shall be completely non-reactive with the laminating resin and shall cause no inhibition of cure, discoloration or acceleration of cure. The mold surface shall be smooth and relatively free of pits and defects.

3.11 PROCEDURE

3.11.1 Cleaning and Preparation Of Molds

3.11.1.1 Cleaning. Residual parting agents and resin shall be removed from the mold surfaces with steel wool followed by surface wiping with clean rag wet with MEK, trichloroethylene or alcohol per Specifications TT-M-00261, O-T-634, Type II, and TT-I-735, respectively.

3.11.1.2 Parting Agents. Parting agents shall be used to facilitate removal of the cured part from the mold. A thin, even coating of the parting agent shall completely cover the surface of the mold. Parting agents shall be allowed to dry before the lay-up is made.

Silicone resin parting agents when used shall be cured to a hard gloss film by one of the following cure cycles:

a. 16 hours at 300°F
b. 8 hours at 350°F
c. 4 hours at 400°F
d. 2 hours at 425°F
e. 1 hour at 450°F
f. 1/2 hour at 475°F

The cured silicone resin film should be renewed when release of parts becomes unsatisfactory.

3.12 LAMINATING

3.12.1 Lay-Up. The impregnated fabric, Drawing SCD1008907, which has been cut to size shall be laid up one ply at a time. Each ply of cloth shall be smoothed out with a heat iron to prevent wrinkling, to ensure close contact with the surface of the mold and to prevent entrapment of air within the laminate.

Care shall be used when applying the heat iron in order to prevent scorching of the fabric, and to prevent excessive flow of the resin. The heat iron shall be kept in motion at all times when in contact with the surface of the assembly.

A hot air blower may be used if the impregnated fabric is too stiff or difficult to form. The application of the hot air will make the fabric more pliable, and it will improve the tack of the material. When applying hot air blower, use care so as not to overheat or scorch the fabric.

3.12.2 Splicing of Plies. Splicing in individual plies may be made unless specifically prohibited by the engineering drawing. When splicing of plies becomes necessary, an overlap of one inch minimum shall be maintained. A minimum lateral distance of two inches shall be held between splice edges in successive plies whenever practical. Where the configuration of the part requires tailoring splices and a minimum of one inch overlap cannot be maintained, the tailoring splices shall be made with a minimum overlap of 0.25 inch. Thickness buildup due to these splices shall be considered when the parts are inspected per 4.4.

3.12.2.1 Butt Joints. Butt joints shall be custom tailored as the ply is laid, taking care the underlying ply is not cut. A strip of teflon sheet may be used as a cutting support. A properly made butt joint will not gap. Layup of butt joints having gaps greater than 0.050 inch and 2 inches in length for each 10 inches of splice will be cause for corrective action. A minimum lateral distance of 2 inches shall be held between splice edges in successive plies wherever practical. Pleats, gathering, fold-overs, wrinkling, or any form of over-lap are prohibited during layup unless specifically called out on the engineering drawing.

3.12.3 Orientation of the Cloth. The warp direction of the cloth as specified on the engineering drawing shall be isotropic, parallel, or optional.

Isotropic lay-up of the cloth shall be in accordance with Table I.

Parallel warp lay-up shall be nested, face to face and back to back. It is not necessary to nest other type lay-ups.

When a drawing or other directive does not specify the type lay-up, the type used shall be optional.

TABLE I

ISOTROPIC LAY-UP

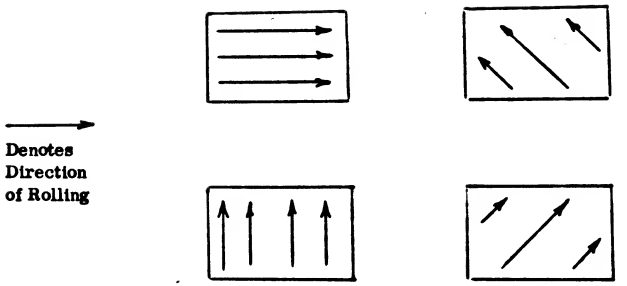
TOTAL NUMBER OF PLIES*	ANGLE BETWEEN WARP OF SUCCESSIVE PLIES**	NUMBER OF PLIES IN EACH ANGLE DIRECTION
3	60° ±3°	1
4	45° ±3°	1
5	36° ±3°	1
6	60° ±3°	2, 2, 2
7	60° ±3°	3, 2, 2
8	60° ±3°	3, 3, 2
9	60° ±3°	3, 3, 3
10	60° ±3°	4, 3, 3

*The eleventh, and subsequent plies, shall be laid-up 60° with the number of plies in each angle calculated as shown for 6 through 10 plies.

**The angle of warp between successive plies shall be obtained with a protractor.

3.12.4 Parting Film. A sheet parting film, shall be perforated and laid on the part covering the entire surface.

The parting film shall be perforated by rolling a spiked roller, over the surface as indicated in Figure 1.



ROLLER DIRECTION

FIGURE 1

The smooth surface of the perforated parting film shall be placed next to the surface of the part.

3.12.5 Pressure Plates. When it is probable that the impregnated cloth will wrinkle during the cure of the laminated part a pressure plate may be used over the area in which it might occur.

The pressure plate shall be assembled on the lay-up of the part after the perforated parting film and one layer of bleeder material have been assembled on the part.

A rigid sheet material, with perforations approximately 1/16 inch in diameter and no more than 1/8 inch apart, shall be used for the fabrication of pressure plates. Care shall be taken to insure open perforations by drilling out any holes that become filled with cured resin.

3.12.6 Vacuum Facilities. Each mold, shall have one vacuum outlet for every four square feet, or less, of the surface of the part.

3.12.7 Bleeder Lay-up. The entire part, vacuum outlets, and springs, shall be covered with the bleeder material, large enough to allow its edges to lie flat against the mold. The bleeder material shall also be placed around the periphery of the part.

Bleeder material shall be as specified and shall be of a total thickness equal to that of the part, except where the contour of the part may cause bridging or otherwise interfere with uniform distribution of vacuum pressure. Combinations of bleeder material may be required to ensure uniform effective pressure and of sufficient thickness to ensure good bleeding action.

Bleeder material shall not be hazardous and shall be a material that is fire-retardant.

3.12.8 Bagging. The entire lay-up shall be placed in a flexible bag. This bag may completely enclose the lay-up and the mold, or the lay-up may be bagged by sealing the bagging material against the mold.

3.12.9 Application of Vacuum. A vacuum shall be drawn slowly to allow the bag to conform to the surface of the part without bridging and to minimize wrinkling of the bag material on the surface of the part.

A minimum of 25 inches of mercury vacuum pressure shall be maintained on the part from the time it is first applied until the part has been completely cured. Bagged parts shall be leak tested at the beginning of the cure cycle as follows:

a. Shut the vacuum line between the gage and the vacuum pump.

b. Observe vacuum gage for indication of leak. A vacuum drop of 1 inch or less in 1 minute is satisfactory. If the vacuum drop is greater, the leak shall be found and repaired.

3.13 CURE CYCLE. Unless otherwise specified the bagged assembly shall be placed into an air circulating oven, and cured at a glue line temperature as shown below:

a. 180 to 210 minutes at 180° ±10°F
b. 30 to 45 minutes at 240° ±10°F
c. 30 to 45 minutes at 260° ±10°F
d. 30 to 45 minutes at 280° ±10°F
e. 30 to 60 minutes at 300° ±10°F

NOTE: The cure shall be continuous from a. through e.

Thermocouples and indicators shall be used to record the temperature required in 3.13 Placement of the thermocouples shall depend on the size and configuration of the assembly to be cured.

The cure temperature of an assembly shall be controlled by the use of standard glue line versus oven air temperature curves. The standard curves shall have been determined for each type of metal mold and each oven used. When this standard curve is used, the thickness of the part may vary from the standards by a maximum of 4 plies.

(For Example: a 12 ply standard curve may be used for curing of parts having a thickness of 8 to 16 plies.)

An alternate method for the control of cure temperatures shall be by a thermocouple placed between the center plies of the trim area of each laminate.

If loss of vacuum occurs during the 180° ±10°F cycle, the bag may be repaired and the cure cycle resumed. Loss of vacuum after this cycle shall be cause for rejection of the part.

3.14 POST CURE. The cured laminates may be removed from the molds and the bag material stripped off. The laminates shall be post cured in an air circulating oven at 350° ±10°F for 2 to 4 hours.

A cured laminate which has a configuration that would tend to warp shall be left on the mold with the bag and bleeder material left in place. The post cure time shall be extended at 350° ±10°F for 3 to 5 hours and shall be conducted under vacuum.

3.15 SECONDARY BONDING. Cured laminated parts which are to be bonded shall be joined using Drawing SCD1008904 adhesive.

3.16 FINISHING LAMINATE BUILD-UP. - When necessary, parts may be machined to meet print dimensions, Sanding of surfaces or edges shall be allowed when it is necessary to prepare surfaces for subsequent processing or to remove excess resin at mold parting lines.

Sanding which results in fraying of surface glass fibers shall be cause for rejection of the part.

NOTE: Sanding through a ply is considered a reduction in laminate thickness and a deviation from the drawing except where design and fabrication methods require machining through a ply.

4. QUALITY ASSURANCE

4.1 TEST SPECIMENS. If the configuration of the part is such that test specimens cannot be cut from the part, one parallel warp, 10 ply control panel 8 inches by 8 inches (181 glass cloth) shall be fabricated with each assembly in accordance with the procedures of this specification and submitted to the tests outlined in 4.2. The control panel shall be fabricated using the same material from the same roll, molded under the same blanket and post-cured with the part it represents.

A single test laminate may be used to represent more than one part when more than one part is cured in a single mold. The test laminate must be laid-up, under the same blanket, and contain materials from the same lot of fabric as the part which it represents.

4.2 FLEXURAL STRENGTH. A minimum of 3 flexure specimens shall be tested to the requirements of Federal Test Method 406, Method 1031.

4.2.1 Specimen Preparation. Machine specimens with length parallel to wrap within ±3 percent. The ends of the specimens shall be parallel to each other within ±0.005 inch.

4.2.2 Test Results. The average of the 3 specimens shall be 50,000 psi minimum. Failure to meet the requirements shall be cause for rejection of the part(s) affected.

4.3 INSPECTION. Inspection shall maintain a check on all processes of fabrication to insure conformance of all applicable specifications and engineering drawings.

Inspection shall maintain records on all parts. Items to be recorded are outlined as follows:

a. Glass fiber cloth - Vendor's roll number
b. Assembly time, start and finish, and date
c. Mold vacuum check at start of cure cycle. Inches of mercury (paragraph 3.2.9).
d. Cure cycle, start and finish, time and temperature.
e. Post cure, time and temperature, start and finish, and date (paragraph 3.4)
f. Completion (time and date)
g. Flexural Test Results (see 4.2)

4.4 THICKNESS OF LAMINATE. Thickness requirements for laminates shall be as specified on the engineering drawing. Thickness requirements for laminates of 181 fabric shall be 0.010±0.001 inch per ply when applicable drawings do not specify thickness.

4.5 ACCEPTABLE WRINKLES. Areas which do not form a portion of the mold surface and which have wrinkles may be accepted without repair if wrinkles do not exceed the following limits, and if the part after machining does not reflect evidence of voids.

a. Intruding wrinkles shall not be below maximum thickness of drawing as measured from the mold surface.

b. Protruding wrinkles shall not exceed in height, one-half the thickness of the laminate (prior to machining) and shall not show evidence of delamination or voids.

4.6 First Article Inspection. The first laminate of each design shall be submitted to the First Article Inspection Committee for evaluation. This evaluation may include disassembly of the laminate.

If the first article is not satisfactory, additional parts shall be evaluated until the committee is satisfied with all phases of its production.

If changes are made in methods of production or tooling, the first article affected shall be submitted to the First Article Inspection Committee for evaluation.

The First Article Inspection Committee shall consist of representatives from both the customer and the supplier.

5. PREPARATION FOR DELIVERY. This section is not applicable to this specification.

6. NOTES. None.

JHH:efo

APOLLO G&N Specification
ND1002315 REV B
Original Issue Date: 5 August 1966
Release Authority: TDRR 30860
Class A Release

PROCESS SPECIFICATION

LAMINATING RESIN IMPREGNATED FABRICS

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				AC	NASA
8/5/66	A	30806	1-11	JP	WLS
12/28/66	B	32372	2-11 was 11 pages, now 12 pages	JP MGM	—

This specification consists of page 1 to 12 inclusive.

APPROVALS	W. L. Swingle 8/30/66 NASA/MSC	J. F. Pizzala 8/30/66	V. Pagliaro P. Recupito	8/30/66

1. SCOPE

1.1 PURPOSE. This specification covers processes for the fabrication and inspection of various resin impregnated fiber cloth systems.

1.2 CLASSIFICATION. The requirements for the processes covered by this specification shall be designated as follows:

a.	Process I (ND1002315-001)	To be used in fabricating SCD1008907 material.
b.	Process II (ND1002315-002)	To be used in fabricating SCD1008917 material.

2. APPLICABLE DOCUMENTS

2.1 EFFECTIVE ISSUES. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, Military Standards and Specifications shall be the issue in effect on the date of request for proposal or invitation to bid.

SPECIFICATIONS

Federal

TT-I-735	Isopropyl Alcohol
O-T-634, Type II	Trichloroethylene, Stabilized
TT-M-00261	Methyl Ethyl Ketone: For Use in Organic Coatings

DRAWINGS

APOLLO G&N

1008907	Phenolic Resin-Glass Cloth Laminating Material
1008917	Phenolic Resin-Refractory Silica Cloth Laminating Material

STANDARDS

Federal Test Method

406	Plastics, Organic, General Specification Test Method

(Copies of specifications, standards, drawings, bulletins, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 SPECIAL MATERIALS AND EQUIPMENT

3.1.1 Parting Agents

3.1.1.1 Wax. "Lusterless" No. 1738, Liquid or Paste, S.C. Johnson & Son, Inc.

3.1.2 Dope-Cellulose Acetate

3.2 PARTING FILM. Cellophane, 300 MAT-2, E.I. DuPont De Nemours, Incorporated.

3.3 SPIKED ROLLER. Any suitable shop perforating tool with spikes approximately 0.050 inch in diameter and spaced approximately 1/2 inch apart.

3.4 MOLD BLEEDER MATERIAL

3.4.1 Canvas. Commercial Grade

3.4.2 Glass Cloth. Commercial Grade

3.4.3 Wood Fiber Mat. Tufflex, 1/2 inch thick UX200 (Fire Retardant), Wood Conversion Company or equivalent.

3.5 BAG SEALING MATERIALS

3.5.1 Masking Tape. No. 200, Minnesota Mining and Manufacturing Company or equivalent.

3.5.2 Double-Coated Masking Tape #401. Minnesota Mining and Manufacturing Company or equivalent.

3.5.3 Sealing Compound. No. 5110, Schnee-Morehead Polymer Corporation or No. 57916 Presstite, Presstite Division, American Marietta Company or equivalent.

3.6 BAG MATERIALS

3.6.1 Polyvinyl Chloride or Polyvinyl Alcohol Film. Reynolon 0.003 and 0.006 inch film, Reynolds Metal Company.

3.6.2 Mylar. 0.003 inch film, E. I. DuPont De Nemours Incorporated.

3.7 EQUIPMENT

a. Heat Iron, Model TF Thermosealer, Wells Mfg. Company or equivalent.
b. Hot Air Blower, Model 12300, Master Appliance Company or equivalent.

3.8 MOLDS. Molds may be either male or female, metallic or non-metallic or any combination. If basically porous materials are used, they shall be so treated to be impervious to air at curing temperatures and pressures. The mold material surface shall be completely non-reactive with the laminating resin and shall cause no inhibition of cure, discoloration or acceleration of cure. The mold surface shall be smooth and shall have 63 finish, maximum.

3.9 PROCEDURE

3.9.1 Cleaning and Preparation of Molds

3.9.1.1 Cleaning. Residual parting agents and resin shall be removed from the mold surfaces with steel wool followed by surface wiping with clean rag wet with MEK, trichloroethylene or alcohol per Specifications TT-M-00261, O-T-634, Type II, and TT-I-735, respectively.

3.9.1.2 Parting Agents. Parting agents shall be used to facilitate removal of the cured part from the mold. A thin, even coating of the parting agent shall completely cover the surface of the mold. Parting agents shall be allowed to dry before the lay-up is made.

3.10 LAMINATING

3.10.1 Lay-Up. The impregnated fabric, which has been cut to size shall be laid up one ply at a time. Each ply of cloth shall be smoothed out with a heat iron to prevent wrinkling, to ensure close contact with the surface of the mold and to prevent entrapment of air within the laminate. Care shall be used when applying the heat iron in order to prevent scorching of the fabric, and to prevent excessive flow of the resin. The heat iron shall be kept in motion at all times when in contact with the surface of the assembly.

A hot air blower may be used if the impregnated fabric is too stiff or difficult to form. The application of the hot air will make the fabric more pliable, and it will improve the tack of the material. When using a hot air blower, extreme care shall be taken so as not to overheat or scorch the fabric.

3.10.2 Splicing of Plies

3.10.2.1 Overlap Joints. Overlap joints in individual plies may be made unless specifically prohibited by the engineering drawing. When overlapping of plies becomes necessary, a one inch minimum shall be maintained. A minimum lateral distance of two inches shall be held between lap edges in successive plies whenever practical. Where the configuration of the part requires tailoring splices and a minimum of one inch overlap cannot be maintained, the tailoring splices shall be made with a minimum overlap of 0.25 inch. Thickness buildup due to these splices shall be considered when the parts are inspected per 4.1.4, and 4.2.4.

3.10.2.2 Butt Joints. Butt joints shall be custom tailored as the ply is laid, taking care the underlying ply is not cut. A strip of teflon sheet may be used as a cutting support. A properly made butt joint will not gap. Layup of butt joints having gaps greater than 0.050 inch and 2 inches in length for each 10 inches of splice will be cause for corrective action. A minimum

lateral distance of 2 inches shall be held between splice edges in successive plies wherever practical. Pleats, gathering, fold-overs, wrinkling, or any form of over-lap are prohibited during layup unless specifically called out on the engineering drawing.

3.10.3 Orientation of the Cloth. The warp direction of the cloth as specified on the engineering drawing may be isotropic, parallel, or optional.

3.10.3.1 Isotropic lay-up of the cloth shall be in accordance with Table I.

3.10.3.2 Parallel warp lay-up may be nested (i.e., face to face and back to back).

3.10.3.3 When a drawing or other directive does not specify the type lay-up, the type used shall be optional.

TABLE I

ISOTROPIC LAY-UP

TOTAL NUMBER OF PLIES*	ANGLE BETWEEN WARP OF SUCCESSIVE PLIES**	NUMBER OF PLIES IN EACH ANGLE DIRECTION
3	60° ±3°	1
4	45° ±3°	1
5	36° ±3°	1
6	60° ±3°	2,2,2
7	60° ±3°	3,2,2
8	60° ±3°	3,3,2
9	60° ±3°	3,3,3
10	60° ±3°	4,3,3

*The eleventh, and subsequent plies, shall be laid-up 60° with the number of plies in each angle calculated as shown for 6 through 10 plies.

**The angle of warp between successive plies shall be obtained with a protractor.

3.10.4 Parting Film. A sheet parting film, shall be perforated and laid on the part covering the entire surface. The parting film shall be perforated by rolling a spiked roller over the surface of the parting film. The perforations produced shall be approximately 1/4 inch spacing. The smooth surface of the perforated parting film shall be placed next to the surface of the part.

3.10.5 Pressure Plates. When it is probable that the impregnated cloth will wrinkle during the cure of the laminated part a pressure plate may be used over the area in which it might occur. The pressure plate shall be assembled on the lay-up of the part after the perforated parting film and one layer of bleeder material have been assembled on the part. A rigid sheet material, with perforations approximately 1/16 inch in diameter and no more than 1/2 inch

apart, shall be used for the fabrication of pressure plates. Care shall be taken to insure open perforations by drilling out any holes that become filled with cured resin.

3.10.6 Vacuum Facilities. Each mold, shall have one vacuum outlet for every four square feet, or less, of the surface of the part.

3.10.7 Bleeder Lay-Up. The entire part and vacuum outlets, and springs, if used, shall be covered with the bleeder material, large enough to allow its edges to lie flat against the mold. The bleeder material shall also be placed around the periphery of the part. Bleeder material shall be as specified and shall be of a total thickness equal to that of the part, except where the contour of the part may cause bridging or otherwise interference with uniform distribution of vacuum pressure. Combinations of bleeder material may be required to ensure uniform effective pressure and of sufficient thickness to ensure good bleeding action.

3.10.8 Bagging. The entire lay-up shall be placed in a flexible bag. This bag may completely enclose the lay-up and the mold. When the mold is too large, the bagging material may be sealed to an exposed surface of the mold in such a fashion as to provide complete enclosure over the part to be molded.

3.10.9 Application of Vacuum. A vacuum shall be drawn slowly to allow the bag to conform to the surface of the part without bridging and to minimize wrinkling of the bag material on the surface of the part. A minimum of 25 inches of mercury vacuum pressure shall be maintained on the part from the time it is first applied until the part has been completely cured. Bagged parts shall be leak tested at the beginning of the cure cycle as follows:

a. Shut the vacuum line between the gage and the vacuum pump.

b. Observe vacuum gage for indication of leak. A vacuum drop of 1 inch or less in 1 minute is satisfactory. If the vacuum drop is greater, the leak shall be found and repaired.

3.11 CURE CYCLE. When laminating with phenolic-glass material per SCD1008907, Process I cure schedule shall be used. If laminating with phenolic-silica material per SCD1008917, Process II cure schedule shall be used.

3.11.1 Process I Cure Schedule.

3.11.1.1 Unless otherwise specified the bagged assembly shall be placed into an air circulating oven, and cured at a glue line temperature as shown below:

a. 180 to 210 minutes at 180° ±10°F
b. 30 to 45 minutes at 240° ±10°F
c. 30 to 45 minutes at 260° ±10°F
d. 30 to 45 minutes at 280° ±10°F
e. 30 to 60 minutes at 300° ±10°F

NOTE: The cure shall be continuous from a. through e.

3.11.1.2 Thermocouples and indicators shall be used to record the temperature required in 3.11.1.1 Placement of the thermocouples shall depend on the size and configuration of the assembly to be cured. Where several parts are in a single oven cure, the thermocouple shall be attached to the largest mold mass for controlling temperature.

3.11.1.3 The cure temperature of an assembly shall be controlled by the use of standard glue line versus oven air temperature curves. The standard curves shall have been determined for each type of metal mold and each oven used. When this standard curve is used, the thickness of the part may vary from the standards by a maximum of 4 plies.

(For Example: a 12 ply standard curve may be used for curing of parts having a thickness of 8 to 16 plies.)

3.11.1.4 An alternate method for the control of cure temperatures shall be by a thermocouple placed between the center plies of the trim area of each laminate.

3.11.1.5 If loss of vacuum occurs during the 180° ±10°F cycle, the bag may be repaired and the cure cycle resumed. Loss of vacuum after this cycle shall be cause for rejection of the part.

3.11.2 Process II Cure Schedule

3.11.2.1 Unless otherwise specified the bagged assembly shall be placed into an air circulating oven, and cured at a glue line temperature as shown in Figure 1.

3.11.2.2 Where several parts of various sizes are in a single oven cure operation, the control thermocouple shall be attached to the largest mold mass for controlling temperature per 3.11.2.

CAUTION: It is recommended that 2 thermocouples be used at the control point. This is to insure continued operation should one thermocouple fail.

3.11.2.3 If loss of vacuum occurs during the 180° ±10°F cycle, the bag may be repaired and the cure cycle resumed. Loss of vacuum after this cycle shall be cause for rejection of the part.

3.12 POST CURE. Both Process I and II cured parts shall be post cured.

3.12.1 The cured laminates may be removed from the molds and the bag material stripped off before post cure.

3.12.2 A cured laminate which has a configuration that would tend to warp shall be left on the mold and post cured under vacuum pressure. Cure and post cure may be one continuous operation. See Note 2, Figure 1.

3.12.3 The laminate shall be post cured in an air circulating oven at 350° ±10°F for 2 to 4 hours.

3.13 FINISHING LAMINATE BUILD-UP

3.13.1 When necessary, parts may be machined to meet print dimensions. Sanding of surfaces or edges shall be allowed when it is necessary to prepare surfaces for subsequent processing or to remove excess resin at mold parting lines.

Sanding which results in fraying of surface glass fibers shall be cause for rejection of the part.

NOTE: Sanding through a ply is considered a reduction in laminate thickness and a deviation from the drawing except where design and fabrication methods require machining through a ply.

FIGURE I

REF. PARA. - 3.11.2.1

NOTE:
(1) Rate of approach set by equipment capability.
(2) Post Cure per Paragraph 3.12. Approach to temperature same as Note (1).

FIGURE I

TIME - TEMPERATURE CURE CONDITIONS FOR
REFRASIL FABRIC REINFORCED PHENOLIC

CRESWELL LYMED CO. NO. C 382 20 DIVISIONS PER INCH BOLH AWAYS 100 BY 200 DIVISIONS
Keuffel & Esser
MADE IN U.S.A. ON CRESWELL TECHNICAL LYMED NO. 1018

4. QUALITY ASSURANCE

4.1 PROCESS I

4.1.1 Test Specimens. If the configuration of the part is such that test specimens cannot be cut from the part, one parallel warp, 10 ply control panel 8 inches by 8 inches shall be fabricated in accordance with the procedures of this specification and submitted to the tests outlined in 4.1.2. The control panel shall be fabricated using the same material from the same roll, molded during the same cure operation and post-cured with the part or parts it represents.

4.1.2 Flexural Strength. A minimum of 3 flexure specimens shall be tested to the requirements of Federal Test Method 406, Method 1031.

4.1.2.1 Specimen Preparation. Machine specimens with length parallel to warp within ±3 percent.

4.1.2.2 Test Results. The average of the 3 specimens shall be 50,000 psi minimum. Failure to meet the requirements shall be cause for rejection of the parts affected.

4.1.3 Inspection. Inspection shall maintain a check on all processes of fabrication to insure conformance of all applicable specifications and engineering drawings.

4.1.3.1 Inspection shall maintain records on all parts. Items to be recorded are outlined as follows:

a. Glass fiber cloth - Vendor's roll number
b. Assembly time, start and finish, and date
c. Mold vacuum check at start of cure cycle. Inches of mercury (paragraph 3.10.9)
d. Cure cycle, start and finish, time and temperature
e. Post cure, time and temperature, start and finish, and date (paragraph 3.12)
f. Completion (time and date)
g. Flexural Test Results (see 4.1.2.2)

4.1.4 Thickness of Laminate. Thickness requirements for laminates shall be as specified on the engineering drawing. Thickness requirements for laminates of 181 fabric shall be 0.010±0.001 inch per ply when applicable drawings do not specify thickness.

4.2 PROCESS II

4.2.1 Test Specimens. If the configuration of the part is such that test specimens cannot be cut from the part, one parallel warp, 10 ply control panel 8 inches by 8 inches shall be

fabricated in accordance with the procedures of this specification and submitted to the tests outlined in 4.2.2 The control panel shall be fabricated using the same material from the same roll, molded during the same cure-operation and post-cured with the part or parts it represents.

4.2.2 Flexural Strength. A minimum of 3 flexure specimens shall be tested to the requirements of Federal Test Method 406, Method 1031.

4.2.2.1 Machine specimens with length parallel to warp within ±3 percent.

4.2.2.2 The average of the 3 specimens shall be 15,000 psi minimum. Failure to meet the requirements shall be cause for rejection of the parts affected.

4.2.3 Inspection

4.2.3.1 Inspection shall maintain a check on all processes of fabrication to insure conformance to all applicable specifications and engineering drawings.

4.2.3.2 Inspection shall maintain records on all parts. Items to be recorded are outlined as follows:

a. Phenolic Impregnated Refrasil fiber cloth - Vendor's roll number

b. Assembly time, start and finish, and date

c. Mold vacuum check at start of cure cycle. Inches of mercury (paragraph 3.10.9)

d. Cure cycle, start and finish, time and temperature

e. Post cure, time and temperature, start and finish, and date (paragraph 3.12)

f. Completion (time and date)

g. Flexural Test Results (See 4.2.2.2)

4.2.4 Thickness of Laminate. Thickness requirements for laminates shall be as specified on the engineering drawing. Thickness requirements for laminates of Refrasil fabric shall be 0.020±0.002 inch per ply when applicable drawings do not specify thickness.

4.3 ACCEPTABLE WRINKLES

4.3.1 Areas which do not form a portion of the mold surface and which have wrinkles may be accepted without repair if wrinkles do not exceed the following limits, and if the part after machining does not reflect evidence of voids.

a. Intruding wrinkles shall not result in a thickness below maximum part thickness of laminate as defined on the drawing and measured from the mold surface.

b. Protruding wrinkles shall not exceed in height, one-half the thickness of the laminate (prior to machining) and shall not show evidence of delamination or voids.

4.4 FIRST ARTICLE INSPECTION

4.4.1 The first laminate of each design shall be submitted to the First Article Inspection Committee for evaluation. This evaluation may include disassembly of the laminate.

4.4.2 If the first article is not satisfactory, additional parts shall be evaluated until the committee is satisfied with all phases of its production.

4.4.3 If changes are made in methods of production or tooling, the first article affected shall be submitted to the First Article Inspection Committee for evaluation.

The First Article Inspection Committee shall consist of representatives from both the customer and the supplier. The area inspector will notify the Quality Control Engineer when first article is ready. The QCE will notify the committee.

5. PREPARATION FOR DELIVERY. This section is not applicable to this specification.

6. NOTES. None

APOLLO G&N Specification
ND1002319 REV A
Original Issue Date:
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ACE-S/C COMPUTER SUBPROGRAM

SPECIFICATIONS FOR APOLLO

CM AND LM G & N TESTING

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	APPROVALS AC	APPROVALS NASA
12/8/66	A	32263	2,3,81,115,199,200,206,209,214-345.	EA	WLS
			Was 345 pages, Now 352 pages. ROX/MC		

This specification consists of 352 total pages.

APPROVALS				
	NASA/MSC	10/13/66		ACED

TABLE OF CONTENTS (Continued)

G&N NUMBER	TITLE	SECTION
152	Special IMU Processing, Block 1 Mod 1	4-152.1
171	ACE-S/C Error Reset Program	4-171.1
181	PIPA Switching and Stabilization Response Test.	4-181.1
210	G & N Downlink Edit Program Block II and LEM	4-210.1
221A	AGC Downlink Format Program Block 2	4-221A.1
224A	CGC Downlink Interpretation Program, Block II	4-224A.1
601	Guidance Computer Clock Initialization Program	4-601.1
602	Guidance Computer Time Verification Program	4-602.1
603	Guidance Computer Time Correction Program	4-603.1
621	Guidance Computer Downlink Format Program	4-621.1
622A	Guidance Computer Display Program	4-622A.1
624A	LEM Downlink Interpretation Program	4-624A.1
624B	LGC Downlink Interpretation Program	4-624B.1
631	Guidance Computer Uplink Verification Program	4-631.1
632	Special K-Start Load-Verify, Verify, and Dump Program	4-632.1
641	G & N High Rate Channel Control Program	4-641.1
652	Special IMU Gimbal Angle Processing	4-652.1
671	ACE-S/C Error Reset Program	4-671.1
681	PIPA Switching and Stabilization Response Test.	4-681.1

Typical outputs from the sin and cos resolvers for one revolution are shown in the figures below.

Figures 152-1 and 152-2 show the ideal case when saturation, or peak voltages E_{ps} and E_{pc}, occurs at $\theta = \pi/4$. The present signal conditioners will have a saturation point at about 74° for the sine resolvers and about 16° for the cosine resolvers. Hence, the calibration data for 45° for each measurement will be less than 254 PCM counts.

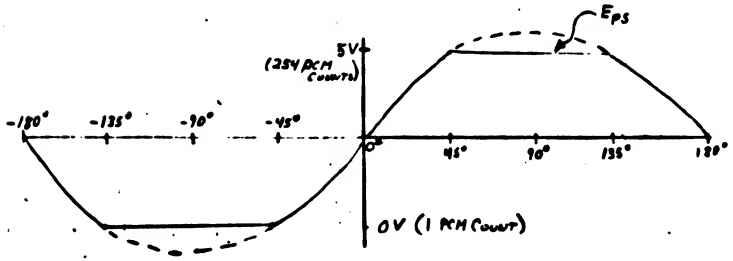


FIGURE 152-1. SIN RESOLVER OUTPUT

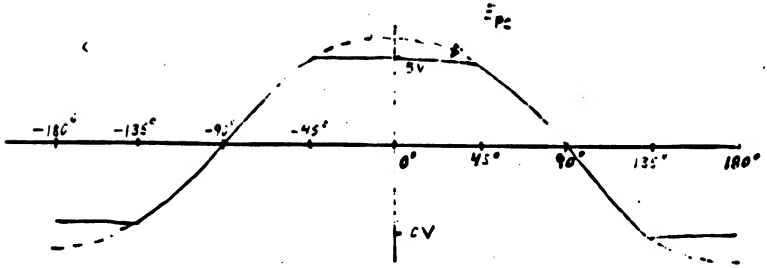


FIGURE 152-2. COS RESOLVER OUTPUT

Range: Each angle has the range of 0° to 360°.

CRT Display: Each angle will be displayed to the nearest degree. The CRT format is as specified in the programming requirements document for the vehicle to be tested.

Filing Requirements: None required

Remarks:

Flow Chart Definitions:

$(SIN\theta)_8$ - Incoming PCM value for the SIN measurement

$(COS\theta)_8$ - Incoming PCM value for the COS measurement

CIS_1 - Calibration input for SIN measurement at point 1 (i.e., 0^o for SIN).

CIC_1 - Calibration input for COS measurement at point 1 (i.e., 90^o for COS).

CIS_6 - Calibration input for SIN measurement at point 6 (ie.e., 45^o)

CIC_6 - Calibration input for COS measurement at point 6 (i.e., 45^o).

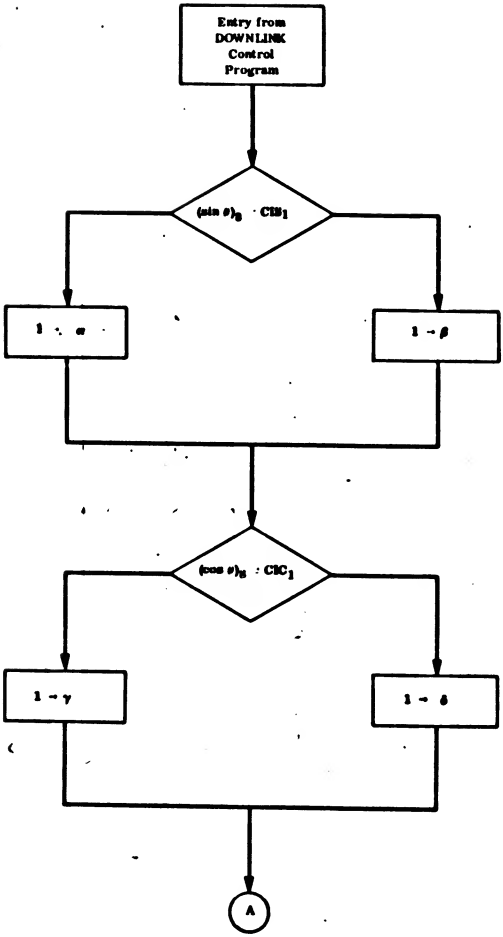


Figure 152-3 (1 of 3)

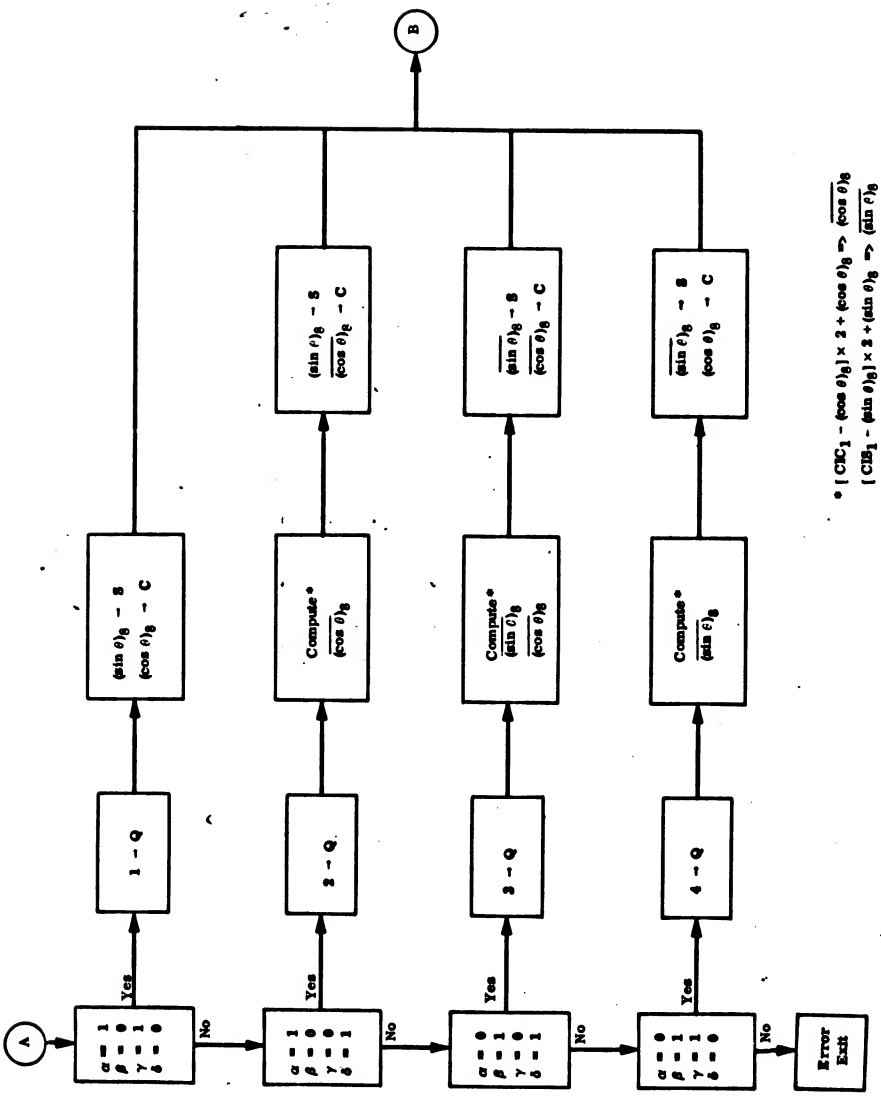


Figure 152-3 (3 of 3)

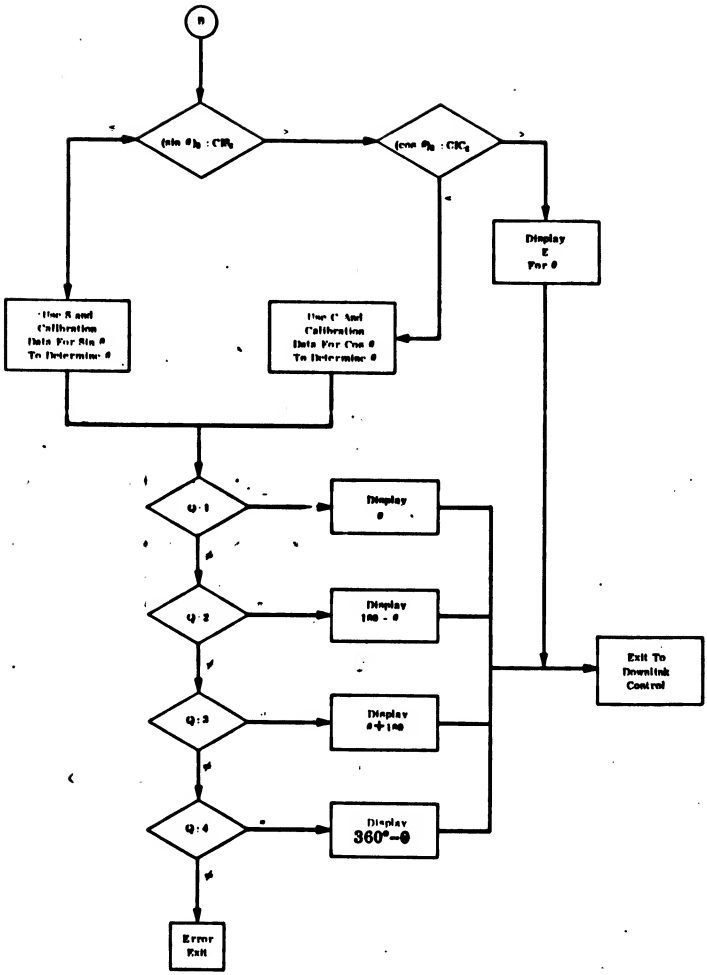


Figure 152-3 (3 of 3)

Title: ACE-S/C Error Reset Program G&N 171

Part Of: Downlink Program

Purpose: This subprogram resets the error displays on the CRT display unit to give a "no error" indication for the ACE-S/C subprograms utilized with the Block I G&N system. These error displays allow monitoring of the ACE system operation during G&N system test.

Calling Sequence: Entry: This subprogram operates under executive control and is initiated from R-START module specified in the PRPS.

Exit: Return to Downlink Executive Program after error displays are reset.

Computation Sequence:

The error displays reset by this subprogram are listed below, along with the ACE-S/C subprogram that generates them during its operation. The CRT page and line location for each error display is detailed in the Program Requirements Process Specification.

G&N Program No.	Error Indication
101	TIME ERROR (1)
102	TIME ERROR (2 or 4)
103	TIME ERROR (3)
121	WORDERR (1 or 2)
G&N Program No.	Error Indication
	MARKERR (1 or 2)
	SYNCERR (2 or 3)
122	RELERR (1)
131	PARERR (1)
	KEYERR (1)
132	VERROR (1, 2, 3, 4, or 5)
181	FSERR (1)

Each error display consists of a variable segment (underlincd) which signifies the type of error condition occuring in a particular ACE program, and a fixed title segment. When initiated by the operator, this subprogram will blank out the variable segments of the error displays.

Operator Action:

Console Operator: Operator action is required to initiate this subprogram via the R-START module.

Spacecraft Operator: No activity required

Uplink Requirements:

The ACE Uplink System is not utilized.

Downlink Requirements:

PCM data stream is not required by this subprogram.

Title: PIPA Switching and Stabilization Loop Response Test G&N 181

Part Of: Uplink Program

Purpose: This program enables a step voltage input into the stabilization loop, for the stabilization servo loop response test, and display of the PIPA signal generator outputs.

Calling Sequence: Entry:

1) This subprogram will operate under executive control and is initiated from an R-START Module specified in the PRPS for the stabilization loop response test.

2) This subprogram is also initiated via a specified R-START Module to allow monitoring of the PIPA signals.

Data: Input to this subprogram is supplied by the CUE upon R-Start execution. This data includes the start module address and the status of the function switches.

Output from this subroutine consists of a series of relay command words.

Normal Exit: Return to Uplink Executive Program.

Error Exit: CRT error display and Uplink Command Tape recording, prior to transfer to the Uplink Executive Program.

Computation Sequence:

Upon R-START execution, this subprogram checks to determine if more than one function switch has been depressed. If so, this program generates an error message for display and recording purposes, blanks out current CRT display and transfers control to the Uplink Executive Program.

The subprogram also checks to see that there was no more than one change in state from the function switches at the previous XEQ. If there has been more than one state this program generates an error message for Uplink Command Filing and transfers control to the Uplink Executive Program without transmitting relay command words Uplink.

A single function switch depression, with only one change of state present, enables the assembly and transmission of relay command words. Refer to the Vehicle Program Requirements Process Specifications for R-START function switch setting and DTCS addresses.

Operator Action: Console Operator: R-START execution is required to initiate this subprogram as given below.

A) Stabilization Loop Step Input

1) The intended status of the relays is selected by depression of the function switches.

2) The step input is applied to the particular IRIG upon depression of the XEQ switch.

3) The removal of the step input is accomplished by again depressing the function switch so that no switches are illuminated, followed by the XEQ switch.

NOTE: When selecting a series of step inputs, item 3) should always be used to insure that the bank of relays are reset, prior to selecting a new step input.

B) PIPA Signal Display

The operator action required for this function is similar to that described for the stabilization loop step input, with the exception of the R-START module location. Only one PIPA signal is displayed at a time and is accomplished by means of the function switch selection as given under Computation Sequence. To remove the PIPA display requires that the operator depress the function switch again and then the XEQ switch.

Spacecraft Operator: No activity required.

Uplink Requirements:

DTCS Transmission: A twenty-four bit command word is compiled in the Uplink computer containing the "carry-on" relay address and the relay status.

DTCS Stimuli: The relay addresses are listed in the Vehicle PRPS.

Transmission Time: During G&N system test, the sequence of subprogram initialization, will be specified in the "Operational Checkout Procedures". All other times, the transmission time will be as required.

Filing Requirements: The complete command history is recorded on the Uplink Command tape.

Downlink Requirements:

CRT Display

1) A display occurs to identify a particular PIPA measurement, appearing on the oscilloscope. The display consists of the following format:

"PIPA MEAS. XXX"

where XXX = REF, X, Y or Z.

The variable portion of the format (underlined) will appear upon operator selection of a PIPA measurement. This display will be blanked when operator action removes this selection by means of the function switches.

2) An error indication is displayed in the following format "FSERR 1". Refer to the "Program Requirements Process Specification" for details on CRT page and line information.

Title: G&N Downlink Edit Program - Block II and LEM

Program Number: G&N No. 210

Purpose: The G&N Downlink Edit Program strips outs, interprets and presents all or any part of the Command Guidance Computer (CGC) and the LEM Guidance Computer (LGC) data recorded on the PCM Data Tape.

Input: The inputs to this program are:

1) PCM Data Tape or Compressed Data Tape containing CGC/LGC data.
2) Edit Parameters (cards or tape)
3) Control cards

Output: The output from this program is a printed listing of CGC/LGC Downlink data taken from the PCM Data tape or CDT for the intervals requested and processed and displayed in the manner defined by the Edit Parameters.

General Program Description: The G&N Downlink Edit-Block II is divided into two segments to minimize the impact of changes in the input data format. The two segments are:

1) EXECUTIVE SEGMENT - This segment prepares the Edit Parameters for use, processes the Control Cards, extracts the CGC/LGC data from the PCM Data tape or CDT for the intervals defined, validates this data and transmits it to the next segment.

2) PRESENTATION SEGMENT - This segment receives the CGC/LGC data and the Edit Parameters from the Executive Segment and processes and prints out this data in the manner prescribed by the Edit Parameters.

Printing: Printing will be once every complete cycle through the Downlink list. The Downlink Edit Format Tables will define either an entire page to be printed (over 6 lines per ID) or a subpage (6 lines or less) to be printed under line count control.

Execution: In most cases, it will not be necessary to see all the data on the PCM Data Tape or CDT. The intervals to be processed will be specified in the Zulu Time as it appears on the PCM Data Tape or CDT and will be input to the program on control cards.

Data Rate: CGC/LGC Data is recorded on analog PCM Data Tapes at bit rates of:
1) 204.8KBS
2) 51.2KBS
3) 1.6KBS
This program must be able to process data at any and all of these rates.

Title: EXECUTIVE SEGMENT

Purpose: The purpose of the Executive Segment is to prepare the Edit Parameters for use by the Presentation Segment, processes the Control Cards, and to extract and validate the required COC/LOC data from the PCM Data Tape.

Input: The inputs to this segment are:

1) Downlink Edit Format and Requirements Tables (Edit Parameters)
2) Data Definition, Title and Time Cards (Control Cards)
3) PCM Data Tape or CDT containing the COC/LOC data to be processed.

Output: The outputs from this segment are:

1) Edit Parameters for use by the Presentation Segment
2) COC/LOC data extracted from the PCM Data Tape or CDT
3) Error signals for any discrepancies found in the Edit Parameters, the Control Cards, and the COC/LOC data.

Normal Exit: The normal exit from this segment is to the Presentation Segment. The normal program halt occurs when the last time interval has been satisfied.

Error Exit: Error signals are generated for discrepancies found in the Input Cards, PCM or CDT Data. The Error Exit is to the Presentation Segment.

Description: The COC/LOC data consists of two types of words:

1) Identification Words (2): These words indicate the type of downlink transmission (List) and signal the start of the data transmission.
2) Data Words (98): Actual COC/LOC words. The position of a data word in a List identifies its content. There is a unique Word Order Code associated with each type of word.

The first card to be input is the Data Definition Card. This card identifies the position of the COC/LOC words in a Prime Frame of PCM Telemetry Data.

The List being sent changes during the various phases of a mission program. A set of Edit Parameters is required for each List. The number of Lists to be used during the missions utilizing Block II Computers is not known; as a preliminary estimate, this program should be able to accomodate up to twenty different lists.

A set of Edit Parameters for any List will consist of:
1) LIST ID card - This card contains the bit configuration (in octal) of the ID Words of the List for which the tables following this card are to be used.

2) R cards - These cards define the print format of the data for the particular list.

3) ENG card - These cards define the English phrase interpretations for the particular List.

4) E Cards - These cards define the processing requirements for the particular list.

5) END Card - This card is the last card of the set of Edit Parameters for the particular List.

This sequence of cards will be repeated for each List.

Run cards to be input with each run will consist of:

1) G&N card - This card will contain the description of the particular run and will be used as a page heading on the output listing.

2) TIME cards - These cards will designate the data to be processed. Each card will contain a start and a stop time in hours, minutes, and seconds. If more than one TIME card is used, the times specified will not overlap and will be in sequence.

3) END OF RUN card - signals the end of the Control Cards.

Appropriate validity checks should be made on the format of these cards. Any card error will suspend the processing of and PCM or CDT Data, but all cards should be scanned and all errors displayed even though no data will be processed.

Usage of the Downlink Edit Program - Block I has shown that the Edit Parameters tend to be fixed once the data content of the Downlink is known. New sets of Edit Parameters will be used only for special applications. The Executive Segment should process the Downlink Edit Format Tables and the Downlink Requirements Tables and save them on tape so that subsequent runs with the same type of data may be made with no reprocessing of those cards.

Time: There is a time signal on the PCM Data Tape and the CDT and the time of transmission of each CGC/LGC word can be determined. This time is matched to the time intervals requested to determine what data is to be processed. Data should be processed from the first ID following the start time to the end of the Downlist after the stop time. The time occurance of the ID Word must be available to the Executive Segment.

Data Form: The CGC/LGC transmitts blocks of five 8 bit words into the PCM stream of telemetry. These forty bits contain the data to be processed. Fifty of these blocks represent a complete cycle through a Downlink List. The Downlist consists of a fixed length of 100 CGC/LGC words, each block representing 2 of these words. The first block of a Downlist contains the ID Words. These words identify the List being transmitted. Following the ID Words are 98 Data words CGC/LGC words are 16 bits in length and are configured as:

8/15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 P

where: bit 15 is the Sign bit for numeric data bits 14 thru 1 are the data bits for numeric data P is the Parity (Odd) bit.

Validation: The Validity checks to be made on the CGC/LGC data are:

1) Check - Out of Sync signaled by DECOM
Action - Message SYNCERR1, indicate which words are out of sync but process anyway.

2) Check - Over ninety-eight data words since ID words
Action - Message SYNCERR2, process first ninety-eight data words and ignore the rest until ID words received.

3) Check - ID Words received before ninety-eight data words were received since last ID Words.
Action - Message SYNCERR3, process data words received begin next Downlist with new ID Words.

4) Check - Parity incorrect in first CGC/LGC word in block
Action - Message WORDERR1, display the 40 bits in Octal and the index number. Do not process the word in error.

5) Check - Parity incorrect in second CGC/LGC word in block
Action - Message WORDERR2, display the 40 bits in Octal and the index number. Do not process the word in error.

6) Check - First ID Word, bits 15 to 11 Invalid
Action - Message WORDERR3

7) Check - First ID Word, bits 10 to 1 Invalid
Action - Message WORDERR4, Invalid ID, display the 40 bits in octal and the index number. Cycle until next ID received.

8) Check - Second ID Word Invalid
Action - Message WORDERR5, display 40 bits in octal. If no error was found in the first ID Word, the ID will be considered Valid and ID word 1 will be used to determine the list being sent.

NOTE: WORDERR3 alone will not invalidate the ID. If no other ID errors are found, bits 10 to 1 of ID word 1 will determine the list being sent.

TITLE: PRESENTATION SEGMENT

Purpose: The Presentation Segment receives the 16 bit COC/LOC words from the Executive Segment. These words are processed in the manner defined by the Downlink Requirements Tables and displayed in the manner defined by the Downlink Edit Format Tables.

Input: The inputs to this segment are:
1) Edit Parameters and ID Word configurations for all Downlists to be processed.
2) The 16 bit COC/LOC Words.
3) Error indicators associated with the 16 bit words transmitted.

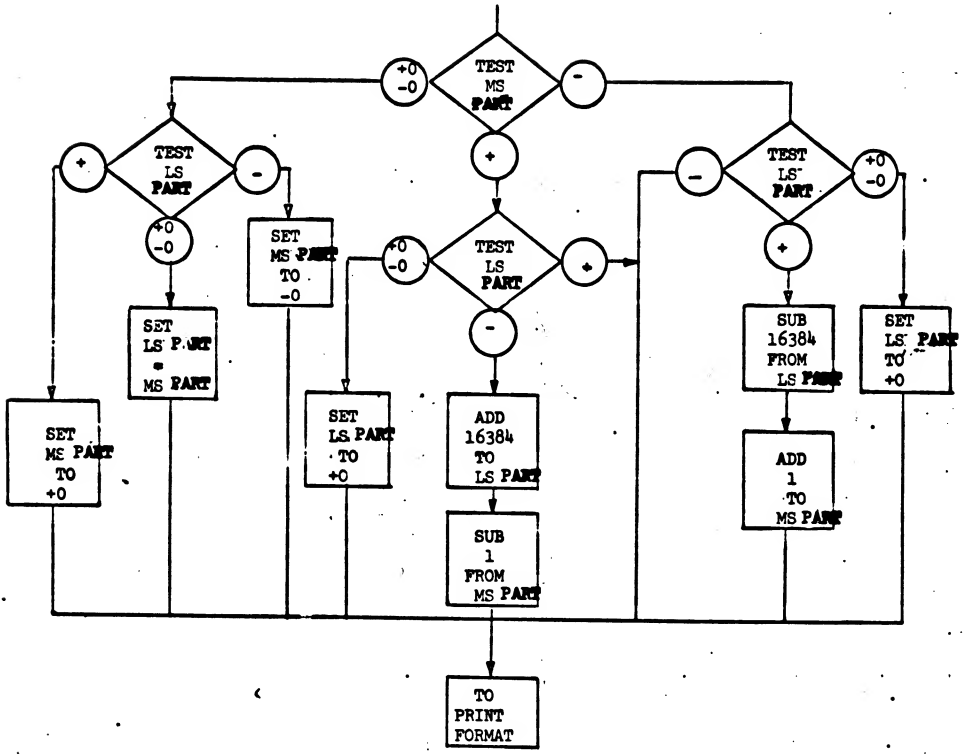
Output: The output from this segment is the printed listing in the formats defined by the Edit Parameters and any error messages generated.

Exits: The normal and the error exits from this segment are to the Executive Segment.

Description: This segment receives the 16 bit COC/LOC words and any error signals from the Executive Segment. Each word is examined to determine if it is an ID Word or a Data Word. When the ID Words are received, the time of their occurance is printed as positioned by an E card. The Edit Parameters for data following the particular ID are made ready for processing. The ID words may be processed as data words for printing. When Data Words are received, a check of the Edit Parameters will determine if the word is to be used, and if so, how to process it. Error signals generate output messages. All COC/LOC words are treated as binary fractions with the binary point between the 15th and 14th bits of the word. Double Precision quantities will require that processing be held up until both words have been received.

Note that the most significant part and the least significant part of a double precision word do not necessarily have the same sign. Use the following diagram for a processing technique.

Method For Handling Double Precision Words:



Card Formats:

Data Definition Card - This card locates the two sixteen bit CGC/LGC words and the word Order Code (WOC) contained in the 40 bits defined. This card also will define the representative WOC bit for ID Words. That is, the bit (0 or 1) indicated will be in each bit position of the WOC for ID Words. The 5-8 bit words will be considered as individual bits numbered 1 to 40 with the left most bit of the first word called bit 1 and numbered consecutively to the right most bit of the fifth word, bit 40.

Columns	Contents	Comments
1 to 4	DATA	defines card type
9 to 11	PCM	comment
22 to 25	WRD1	comment
27 to 31	XX-XX	first and last bit position of CGC/LGC word 1
34 to 37	WRD2	comment
39 to 43	XX-XX	first and last bit position of CGC/LGC word 2
46 to 48	WOC	comment
50 to 54	XX-XX	first and last bit position of word order code
57 to 61	IDWOC	comment
63	X	WOC representative bit for ID Words

Comments need not be checked for. The CGC/LGC words should be 16 bits in length, the word order code may be from 1 to 8 bits. All WOC bits will be identical if more than one is specified. The representative WOC bit for ID words is supplied. Data word WOC is assumed to be the complement of the ID WOC. See card example page for further clarification.

Downlink Edit Format Tables: A Downlink Edit Format Table is required for each Downlist to be processed. This table specifies the fixed format layout of the edit listing. A field width of 120 print characters is required. The spacing alloted between the title entries of this table is for the insertion of the CGC/LGC data as processed by the Presentation Segment. This table is composed of R cards. These cards provide the titled entries for the edit listing. No more than two cards are used to define any single line of the listing. The set of R cards for any Downlist will not define over 50 lines including spacing.

Columns	Contents	Comments
1	R	defines card type
6, 7	XX	line sequence number
8	y	print control
9 to 80		fixed format layout

where: XX R cards for a particular List are in sequence by this number. This number is used by the E cards to identify the lines on which the processed data will be displayed.

y = blank or 1, skip one line after printing
= 2, skip two lines after printing
= 9, fixed format layout of this card is the right most poriton of the previously defined line

If y is blank, 1, or 2, columns 9 thru 80 of the card will be printed in print positions 1 to 72.
If y is 9, columns 9 thru 56 will be printed in print positions 73 to 120.

Downlink Requirements Tables:

A Downlink Requirements Table is needed for each Downlist to be processed. This table defines the specific entries required for the edit listing by referencing the index number (word position in Downlist) of the words to be processed. This table specifies the exact placement, in terms of print positions, of each data entry in the fixed edit format defined by the Downlink Edit Format Table for this Downlist. This table also specified the processing required for each data entry in the output. A Downlink Requirements Table is composed of E cards and ENG cards.

Columns	Contents	Comments
1	E	defines card type
9, 10	XX	line number (match to R card line sequence number)
12 to 18	XXX-XXX	print positions in output line where this entry is to be displayed.
25 to 30	EQUALS	
32 to 34	XXX	index number (001 to 100)
	For quantitites to be displayed in decimal	
36 to 62	DP or SP (Double or Single Precision), Scale Factor (sign, decimal point, one to ten decimal digits), power (E, sign, one or two decimal digits), S or NS (if S, print sign; if NS treat word as 15 bit unsigned number), MSB (for double precision, indicates most significant bits)	
	For other quantitites	
36 to 50	XX or XX-XX or XX,XX-XX (bit positions to be considered - leading zeros not supplied) OCTAL (print bits indicated in octal) or BINARY (print bits indicated in binary) or ENGn (Extract bits indicated and search English table specified for match and insert associated phrase in output), I or blank (I, if bit 15 of the word is a 1, the bits indicated must be complimented before processing; if field is blank or if bit 15 is 0, the bits indicated are used as is).	
	Fields will be seperated by commas, and except where mentioned, lead zeros will be supplied.	

The ENGn cards contain English phrases to inserted in the output listing when certain combination of bits are present in key CGC/LGC words. The bits for comparison and the table to be searched are indicated by E cards.

Columns	Contents	Comments
1 to 3	ENG	defines card type
4	n	table number (n = 1 to 8)
8 to 23	1 to 16 binary characters that is the bit pattern for which the English phrase will be substituted (bits specified n in E card are extracted and compared to the non-blank columns - right justified to column 23)	
25 to 30	EQUALS	
33 to 53	1 to 20 alphanumeric characters to be inserted in print positions defined in the E card - left justified to column 33. A $ in column 33 means that no phrase is to be inserted for the bit pattern matched.	

Downlink Requirements Tables:

If the designated ENGn table is searched and no match is found, an error condition exists. A message, DOWNERR1 is printed along with the index number of the word that contained the bits that could not be matched and the word (16 bits) in octal.

NOTE:

A special application of the E card will be used to position the time of the ID word in the edit listing. Index word 000 will indicate this time and it will be positioned in the normal manner. E.G.
E 06,018-037 EQUALS 000
Print GMT on the line defined by R 06 in print positions 018 through 037. The processing requirements for this word are already defined.

List Identification Card - This card is the first card of the set of Edit Parameters for a particular Downlist. The bit configurations of the ID Words, whose data will be processed according to the tables following this card, are contained in this card.

Columns	Contents	Comments
1 to 4	LIST	defines card type
7 to 12	XXXXXX	bit configuration in Octal of first ID word
15 to 20	XXXXXX	bit configuration in Octal of second ID word

The 16 binary bits are converted into 6 octal characters by adding two binary zeros to the right to make 18 binary bits E.G. (1100100001101111) will be in the card as 620674.

End Card - This card is the last card of the set of Edit Parameters for a particular Downlist.

Columns	Contents	Comments
1 to 3	END	defines card type

The Edit Parameters for each Downlist consist of: LIST ID card, R cards, ENGn cards, E cards and the END card in that order.

Cards Input for each run: The page title card contains the run description, date, OCP, etc, and is printed once per page.

Columns	Contents	Comments
1 to 3	G&N	defines card type
5 to 75	page title	to be printed as the first line of each page.

The data to be processed are defined as a set of 1 to n time intervals. Each card contains the start and stop time of a data interval. For multiple intervals, the times will not overlap and will be in sequence.

Columns	Contents	Comments
1 to 4	TIME	defines card type
6, 7	XX	start time, hours
8, 9	YY	start time, minutes
10, 11	ZZ	start time, seconds
13, 14	TO	
16, 17	XX	stop time, hours
18, 19	YY	stop time, minutes
20, 21	ZZ	stop time, seconds

The last card to be input is the End of Run card.

Columns	Contents	Comments
1 to 10	END OF RUN	defines card type

Example 1 E 02, 018-026 EQUALS 062,DP,+.16777528E+5,S,MSB

E - specifies requirements equals card
02 - specifies the number of a R card entry in the Edit Format table which designates the line that this data is to be printed on.
018-026 - specifies the print positions of line 02 that this data is to be printed in
062 - specifies the position in the Downlink List (index number) that contains the data to be processed.
DP - specifies that the data is double precision
+.16777528 - specifies the numeric value of the scale factor
E+5 - specifies the power of the scale factor
S - specifies the data is a signed number
MSB - specifies that word 062 is the most signifient bits of the double precision quantity.

This card requires that the 14 data bits of word 062 and the 14 data bits of word 063 be combined as previously described into a 28 bit binary fraction, converted to a decimal fraction, multiplied by 16777.528 and printed in positions 018 to 026 of line 02.

Example 2 E 61,047-062 EQUALS 029,7,5-1,ENG2

E - specifies requirements Equals card
61 - specifies the number of the R card entry
047-062 - specifies the print positions of R 61 for display
29 - specifies the eindex number of the data
7,5-1 - specifies the bits to be extracted from word 029
ENG2 - specifies the table of English phrases that is to be searched for the same pattern of the bits extracted.

This card requires that bits 7 and 5 thru 1 be extracted from word 029. These bits are then compared to the patterns that are part of English phrase table ENG2. When the bits are matched, the English phrase associated with that pattern is printed in print positions 047 to 062 of the line defined by R card 61.

Example 3 E 04, 109-109 EQUALS 012,6,BINARY

E - specifies requirements Equals card
04 - specifies the number of a R card entry
109-109 - specifies the print position on line defined by R04
012 -specifies the index number of the data
6 - specifies the bit position to be extracted from word 12
BINARY - specifies that the bit be displayed in binary.

Example 4 E 06,097-112 EQUALS 026,15-1,OCTAL

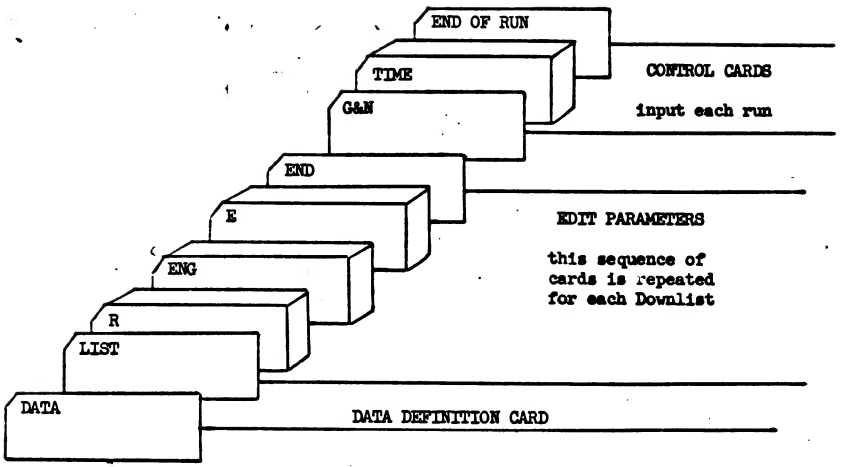
E - specifies requirements Equals card
06 - specifies the R card line number
097-112 - specifies the print position in the line defined by R 06
026 - specifies the index number of the CGC/LGC data
15-1 - specifies the bits of word 012 to be processed
OCTAL - specifies that the data is to be printed in octal

Example 5 ENG2 001001 EQUALS FINE ALIGN

ENG2 - specifies requirements English card
001001 - specifies the bit pattern that will be interpreted by the english phrase
FINE ALIGN - specifies the message that is to be printed in the print positions called out by the E card that refers to the ENG2 table.

This card is actually a sub-card to an E card. The E card specifies the bits of a CGC/LGC word to be compared to the various entries of the ENG2 table and the print positions for the message.

Input Card Deck Makeup:



Input Card Examples:

```
DATA    PCM     WRD,I  02-17   WRD,2  15I    33   MSC 011-01  IDW&C II
LIST    0116254 0043174                                        IMU MODE
R       0122AGC TIME    001(001 EQUALS  ZERO ENCODER          AGC ID
E       02,.0118-0026   EQUALS  0116,DP,+.7456SH04H2EH3,S,,MSB
E       45,.0141-0120   EQUALS  0125,SP,+.18CEH3
E       53,.0381-0541   EQUALS  0120,17,5-1,,ENG2,I
E       05,.0410-0440   EQUALS  0113,,1,,BINARY
E       06,.0419-0423   EQUALS  0113,,15-1,,OCTAL
END     COMPRESSED TIME MISSION SIMULATION  AS-202   IOCP-K00335 6/6/66
6+N     1455112 TRG 1153220
TLM     RUN
ENC
```

References: 1) AC Electronics Diagnostic Program Specification for CMC Block I (CMCD1) - G&N Downlink Edit, Block I

2) [illegible] - ACE S/C Subprogram Specification for the Downlink Format Program, LGC Block II (G&N 621)

3) [illegible] - ACE-S/C Subprogram Specification for the ACE G&N Downlink Edit Program (G&N 010)

Title: GC Downlink Format Program, Block II G&N 221A

Part Of: Downlink Program

Purpose: The GC transmits blocks of five 8-bit words into the PCM T/M at a 50 block per second rate. These data blocks represent a complete cycle through one GC Downlist. The Downlist consists of a fixed length of 100 GC words, each data block representing 2 of these words. The list address contained in the ID word identifies the transmitted parameters.

The Downlink Format subprogram accepts each block of five 8-bit words, verifies parity, and reformats each word into a 16-bit format. The type of GC word represented is identified and the word is routed to other ACE-S/C subprograms for subsequent processing.

Calling Sequence: Entry: This subprogram operates under Downlink Executive Program control and is initiated by receipt of an Executive program interrupt.

Data: 1) A sequence of 50 blocks of five 8-bit words during 1 second.

2) Notification upon loss of a block (prime frame) or sequence of 50 blocks (sub-frame).

Normal Exit: Valid data is transmitted to the appropriate ACE-S/C subprogram for further processing and display.

Error Exit: Error conditions will be displayed on the CRT and filed. A search for an ID word to enable further data processing, occurs under certain error conditions. The CRT error displays are detailed in Table 221A-1.

Computation Sequence:

The program receives blocks of five 8-bit words, configured as follows:

WORD 1	WOC	S/15	14	13	12	11	10	9
WORD 2	8	7	6	5	4	3	2	1
WORD 3	P	S/15	14	13	12	11	10	9
WORD 4	8	7	6	5	4	3	2	1
WORD 5	P	X	X	X	X	X	X	X

where WOC = Word order code (1 bit)
P = Odd parity (GC word)
X = 0 as presently configured

The data block contains 2 GC 16-bit data or DSPTAB words, except where an ID word is encountered. The individual word formats are specified below. The GC data word includes a parity (P) and sign (S) bit. (See Figure 221A.1)

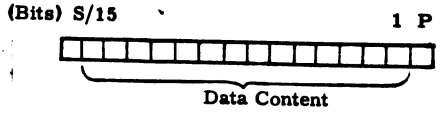
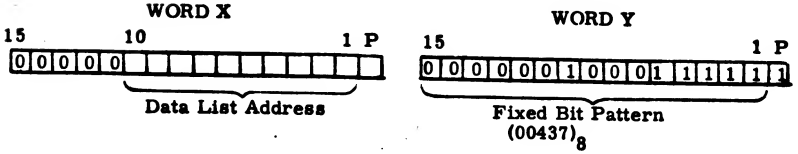


Figure 221A.1

The DSPTAB word format is essentially as specified in Figure 221A.1, as far as this program is concerned.

The identification (ID) word format contains five leading zeros with bits 1-10 containing the data list address. The complete ID word format is:



Word X precedes Word Y in the data block transmittal (Word 1 - Word 5). The Word order code (WOC) bit contains a 1 for all data and DSPTAB words, and a 0 for the ID word. The position of the LGC word in the fixed length list determines whether the word is to be processed for data monitoring or for DSKY display monitoring. The specified Downlink lists which initiate the operation of this program are contained in G&N 224A,Table 224A.1.

Basically, Program G&N 221A receives PCM data blocks, checks parity, and determines the word type, to allow the transfer of 16-bit words to ACE-S/C programs for subsequent processing. A word count is utilized to detect any deviation from the normal list transmission. A block count is also utilized to indicate if both words in the data block have been processed and so allow the reading in of another block.

When an error is sensed, display and recording of pertinent information takes place and depending upon the type of error, control is transferred to point C in the flow chart (Figure 221A-2 where a search for an ID word is initiated.

If a DSPTAB word is detected, then bit 15 is checked for a '1' indication. If a '1' is encountered the word must be complemented prior to transmitting the word to G&N 622A for further processing. Upon detection of an ID word, the data list address is transmitted to G&N 224A to allow that program to utilize the correct display format and scaling information. Figure 221A-2 is given as a representative flow, to convey the intent of the subprogram operation.

Operator Action:	Console Operator: No activity required.
Spacecraft Operator:	No activity required.
Uplink Requirements:	Not applicable.
Downlink Requirements:	Display: This information is detailed in the flow chart and consists of program error displays as specified in Table 221A-1. The ACE requirements specification contains the CRT page and line information.
Filing Requirements:	Upon detection of an error the following information shall be recorded: Time, error name, error number, Data block containing the error and word count.
References:	ACE-S/C Computer Subprogram, G&N 224A Downlink Interpretation Program.

TABLE 221A-1

Error Description	CRT Display
This indicates that Wordcnt has incremented beyond a specified limit.	SYNCERR 1
At this point Wordcnt should be 101, if an ID has been received in the correct sequence.	SYNCERR 2
Parity is incorrect in the first LGC word in data block.	WORDERR 1
Parity is incorrect in the second LGC word in data block.	WORDERR 2
ID word (bits 11 - 15) $\neq (00)_8$	WORDERR 3
Fixed bit pattern in ID word is illegal.	WORDERR 4
Invalid list address encountered after attempting to utilize second LGC word to identify ID word.	WORDERR 5
Invalid list address encountered in the first LGC word in data block.	WORDERR 6

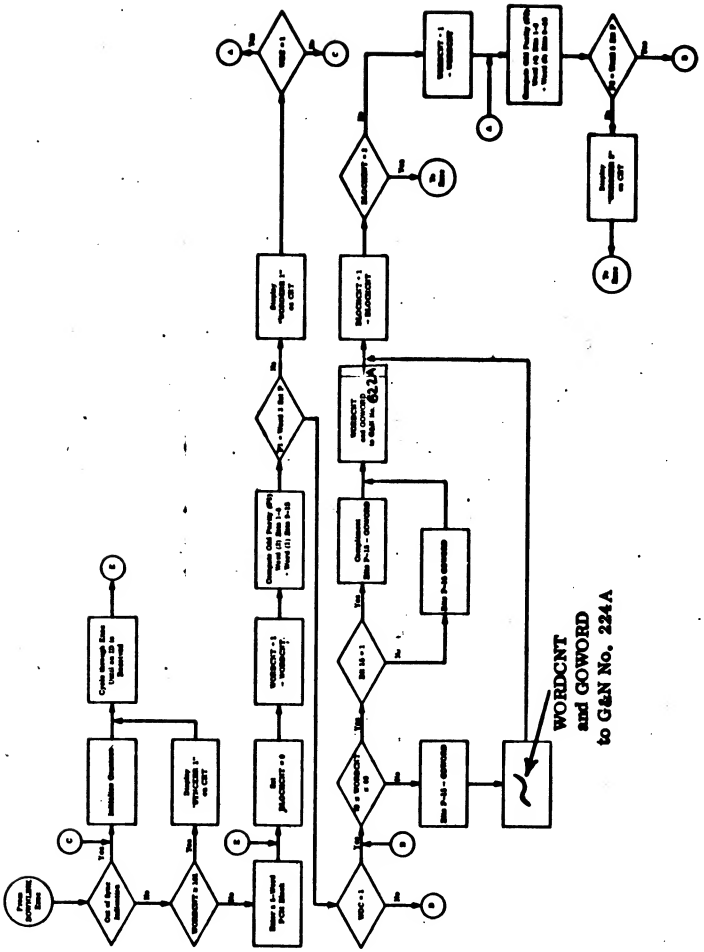


Figure 221A-2 (1 of 2)

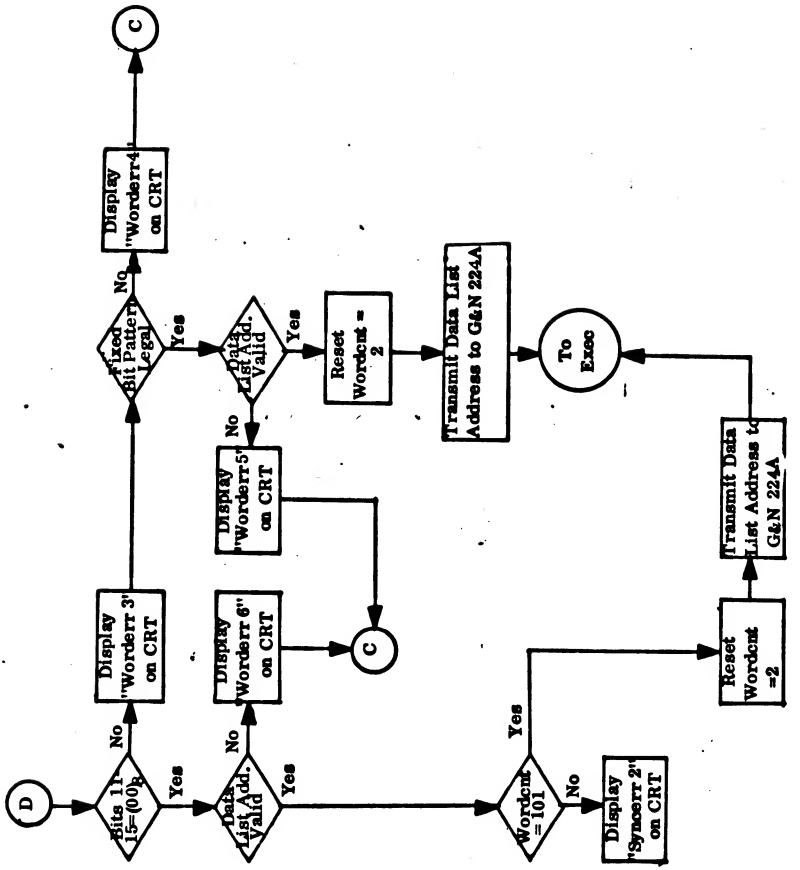


Figure 221A-2 (2 of 2)

Title: GC Downlink Interpretation Program, Block II G&N 224A

Part Of: Downlink Program

Purpose: This subprogram defines the interpretation of the GC Downlink data which is required for ACE-S/C console operator usage and information. The processing requirements for the Nominal GC Downlink list for SUNDIAL is included in this document.

Calling Sequence: Entry: This subprogram is activated by the GC Downlink Format Program, G&N 221A whenever the Format Program is processing Downlink data.

Data Input: Input from G&N 221A to the Downlink Interpretation Program consists of a 16-bit GC data word stored in the computer. Two types of GC words will be processed by G&N 224A:

1) Identification: This word specifies the data list which is being received by G&N 221A.

2) Data: Actual GC data words. The position in the list identifies the data being processed.

Data Output: Output will consist of CRT displays and processed parameters stored in temporary buffers for use by other ACE-S/C G&N. Subprograms and data to be filed if required.

Normal Exit: Return to ACE Executive Program which will supply more data to G&N 221A.

Error Exit: None

Computation Sequence: The Nominal Downlink List for the GC is transmitted once per second and consists of 100 words (two per prime frame).

Table 224A-1 describes the contents of the List and provides the processing requirements for each word.

Operator Action: Console Operator - No activity required.

Spacecraft Operator - No activity required.

Uplink Requirements:

No stimuli required.

Downlink Requirements:

Data Manipulation - Found in the computation sequence section.

CRT Display - The ACE Requirements Specification contains the CRT scope page and line information.

Filing Requirements: Execution of the "RECORD" R-START module function switch specified in the PRPS will cause the filing of a time tag and the following:

Octal words: ID, FAILREG, THETA D, THETA D+1, THETA D+2 STATE, STATE +1, STATE +2, STATE +3

Single Precision Words: CDUX, CDUY, CDUZ, CDUT, CDUS, REDOCTR

Double Precision Words: (TIME 1, TIME 2)

Event Words: IMODES 30, OPTMODES, DSTAB +11, CHNL 11, CHNL 12, CHNL 13, CHNL 30, CHNL 31, CHNL 32, CHNL 33.

Table 224A-1
Nominal GC Downlink List

Word NO.	Word Name	G&N 224A Processing Requirements
1	01724	None
2	00437	None
3	PIPAX	Defined in Table 224A-2
4	PIPAY	Defined in Table 224A-2
5	PIPAZ	Defined in Table 224A-2
6	BMAGX	Defined in Table 224A-2
7	BMAGY	Defined in Table 224A-2
8	BMAGZ	Defined in Table 224A-2
9	PUSHLOC	None
10	PRIORITY	None
11	LOC	None
12	BANKSET	None
13	DELVX	None
14	DELVX+1	None
15	DELVX+2	None
16	DELVX+3	None
17	DELVX+4	None
18	DELVX+5	None
19	SELFRET	None
20	SMODE	None
21	SFAIL	None
22	ERCOUNT	None
23	IMODES30	Defined in Table 224A-2
24	IMODES33	None
25	DESOPTT	None
26	DESOPTS	None
27	CDUX	Defined in Table 224A-2
28	CDUY	Defined in Table 224A-2
29	CDUZ	Defined in Table 224A-2

Table 224A-1 (Continued)

Word No.	Word Name	G&N 224A Processing Requirements
30	CDUT	None
31	CDUT	Defined in Table 224A-2
32	CDUS	Defined in Table 224A-2
33	STATE	None
34	STATE+1	None
35	STATE+2	None
36	STATE+3	None
37	REDOCTR	Defined in Table 224A-2
38	FAILREG	Defined in Table 224A-2
39	OPTMODES	Defined in Table 224A-2
40	SWSAMPLE	None
41	DESOPMOD	None
42	WTOPTION	None
43	IMUCADR	None
44	OPTLADR	None
45	THETAD	None
46	THETAD+1	None
47	THETAD+2	None
48	DESOPTT	None
49	MARKSTAT	None
50	TIMESAV	None
51	DRIFTO	Defined in Table 224A-2
52	DRIFTO+1	None
53	DRIFTI	Defined in Table 224A-2
54	DRIFTI+1	None
55	DRIFTT	Defined in Table 224A-2
56	DRIFTT+1	None
57	GAZIMUTH	None
58	GAZIMUTH+1	None
59	ANGZ	Defined in Table 224A-2
60	ANGZ+1	None

Table 224A-1 (Continued)

Word No.	Word Name	G&N 224A Processing Requirements
61	ANGY	Defined in Table 224A-2
62	ANGY+1	None
63	ANGX	Defined in Table 224A-2
64	ANGX+1	None
65	VLAUN	None
66	VLAUN+1	None
67	WPLATO	None
68	WPLATO+1	None
69	WPLATI	None
70	WPLATI+1	None
71	WPLATT	None
72	WPLATT+1	None
73	PIPAN	Defined in Table 224A-2
74	INTVEC+1	None
75	PIPAE	Defined in Table 224A-2
76	INTVEC+3	None
77	UPLOCK	Defined in Table 224A-2
78	TGLOC	None
79	DSPTAB+0	None
80	DSPTAB+1	None
81	DSPTAB+2	None
82	DSPTAB+3	None
83	DSPTAB+4	None
84	DSPTAB+5	None
85	DSPTAB+6	None
86	DSPTAB+7	None
87	DSPTAB+8	None
88	DSPTAB+9	None
89	DSPTAB+10	None
90	DSPTAB+11	Defined in Table 224A-2

Table 224A-1 (Continued)

Word No.	Word Name	G&N 224A Processing Requirements
91	TIME2	Defined in Table 224A-2
92	TIME1	Defined in Table 224A-2
93	CHANNEL 11	Defined in Table 224A-2
94	CHANNEL 12	Defined in Table 224A-2
95	CHANNEL 13	Defined in Table 224A-2
96	CHANNEL 14	None
97	CHANNEL 30	Defined in Table 224A-2
98	CHANNEL 31	Defined in Table 224A-2
99	CHANNEL 32	Defined in Table 224A-2
100	CHANNEL 33	Defined in Table 224A-2

TABLE 224A-2

WORD NO.	WORD NAME	BITS	DATA MANIPULATION See Notes (-)	DISPLAY	SCALE FACTOR
3	PIPAX	1-15	CONVERT TO DECIMAL	PIPAX±XXXXX	1
4	PIPAY	1-15	CONVERT TO DECIMAL	PIPAY±XXXXX	1
5	PIPAZ	1-15	CONVERT TO DECIMAL	PIPAZ±XXXXX	1
6	BMAGX	1-15	CONVERT TO DECIMAL	BMAGX±XXXXX	1
7	BMAGY	1-15	CONVERT TO DECIMAL	BMAGY±XXXXX	1
8	BMAGZ	1-15	CONVERT TO DECIMAL	BMAGZ±XXXXX	1
23	IMODES30	1	(a)	IGN PIP FAIL ON (OFF)	N/A
23	IMODES 30	2	NONE	N/A	
23	IMODES30	3	(a)	IGN ICDU FAIL ON (OFF)	N/A
23	IMODES30	4	(a)	IGN IMU FAIL ON (OFF)	N/A
23	IMODES30	5	NONE	N/A	N/A
23	IMODES30	6	(a)	INITIALIZE ISS ON (OFF)	N/A
23	IMODES30	7-15	NONE	N/A	N/A
27	CDUX	1-15	(j)	CDUX XXX. XX DEG	N/A
28	CDUY	1-15	(j)	CDUY XXX. XX DEG	N/A
29	CDUZ	1-15	(j)	CDUZ XXX. XX DEG	N/A
31	CDUS	1-15	(i)	CDUS XX. XXX DEG	N/A
32	CDUS	1-15	CONVERT TO DECIMAL	CDUS XXX. XX DEG	$180°/2^{14}$
37	REDOCTR	1-15	CONVERT TO DECIMAL	REDOCTR XXXXX	$180°/2^{14}$
38	FAILREG	1-15	DISPLAY IN OCTAL	FAILREG XXXXX	N/A
39	OPTMODES	1	NONE	N/A	N/A
39	OPTMODES	2	(a)	IGN OCDU FAIL ON (OFF)	N/A
39	OPTMODES	3	(a)	OPT ZEROING ON (OFF)	N/A
39	OPTMODES	4-5	(c)	OPT SWITCH XXX	N/A
39	OPTMODES	6-15	NONE	N/A	N/A
51	DRIFTO	1-15	CONVERT TO DECIMAL	V DRIFTO±XXX. XX MERU	$1000/2^{14}$
53	DRIFTI	1-15	CONVERT TO DECIMAL	S DRIFTI±XXX. XX MERU	$1000/2^{14}$
55	DRIFTT	1-15	CONVERT TO DECIMAL	E DRIFTT±XXX. XX MERU	$1000/2^{14}$
59	ANGZ	1-15	CONVERT TO DECIMAL	ANGZ±. XXXXX	$1/2^{14}$

TABLE 224A-2

WORD NO.	WORD NAME	BITS	DATA MANIPULATION See Notes (-)	DISPLAY	SCALE FACTOR
61	ANGY	1-15	CONVERT TO DECIMAL	ANGY±.XXXXX	$1/2^{14}$
63	ANGX	1-15	CONVERT TO DECIMAL	ANGX±.XXXXX	$1/2^{14}$
73	PIPAN	1-15	CONVERT TO DECIMAL	PIPAN±XXXXX	1
75	PIPAE	1-15	CONVERT TO DECIMAL	PIPAE±XXXXX	1
77	UPLOCK	1	(a) (d)	UPLOCK ON (OFF)	N/A
77	UPLOCK	2-15	NONE	N/A	N/A
90	DSTAB+11	1-3	NONE	N/A	N/A
90	DSTAB+11	4	(a)	NO ATTITUDE ON (OFF)	N/A
90	DSTAB+11	5	NONE	N/A	N/A
90	DSTAB+11	6	(a) (d)	GIMBAL LOCK ON (OFF)	N/A
90	DSTAB+11	7	NONE	N/A	N/A
90	DSTAB+11	8	(a)	TRACKER FAIL ON (OFF)	N/A
90	DSTAB+11	9	(a)	PROGRAM ALM ON (OFF)	N/A
90	DSTAB+11	10-15	NONE	N/A	N/A
91	TIME 2 (MS)	1-15	(e) (f) CONVERT	CMC TIME XXXX HRS XX MIN	1/360,000
92	TIME 1 (LS)	1-15	TO DECIMAL	XX.XX SEC	
93	CHNL 11	1	(a)	ISS WARNING ON (OFF)	N/A
93	CHNL 11	2	(b)	COMPUTER	N/A
93	CHNL 11	3	(b)	UPLINK	N/A
93	CHNL 11	4	(a)	TEMP CAUTION ON (OFF)	N/A
93	CHNL 11	5	(a)	KEY RELEASE ON (OFF)	N/A
93	CHNL 11	6	(a) (g)	FLASH VERB-NOUN ON (OFF)	N/A
93	CHNL 11	7	(a) (h)	OPERATOR ERR ON (OFF)	N/A
93	CHNL 11	8-12	NONE	N/A	
93	CHNL 11	13	(a)	ENGINE ON ON (OFF)	N/A
93	CHNL 11	14-15	NONE	N/A	N/A
94	CHNL 12	1	(a)	ZERO OPT CDUS ON (OFF)	N/A
94	CHNL 12	2	(a)	ABL OPT ER CTR ON (OFF)	N/A
94	CHNL 12	3	NONE	N/A	N/A
94	CHNL 12	4	(a)	COARSE ALIGN ON (OFF)	N/A
94	CHNL 12	5	(a)	ZERO ICDUS ON (OFF)	N/A

TABLE 224A-2 (Continued)

WORD NO.	WORD NAME	BITS	DATA MANIPULATION See Notes (-)	DISPLAY	SCALE FACTOR
94	CHNL 12	6	(a)	IMU ERR CTR ON (OFF)	N/A
94	CHNL 12	7	NONE	N/A	N/A
94	CHNL 12	8	(a)	TVC ENABLE ON (OFF)	N/A
94	CHNL 12	9	(a)	SAT TAKOVR ABL ON (OFF)	N/A
94	CHNL 12	10-12	NONE	N/A	N/A
94	CHNL 12	13	(a)	SAT INJ SEQ ST ON (OFF)	N/A
94	CHNL 12	14	(a)	SAT CUTOFF ON (OFF)	N/A
94	CHNL 12	15	(a)	ISS TRNON COMP ON (OFF)	N/A
95	CHNL 13	1-4	NONE	N/A	N/A
95	CHNL 13	5	(a)	INHIBIT UPLINK ON (OFF)	N/A
95	CHNL 13	6-7	NONE	N/A	N/A
95	CHNL 13	8	(a)	BMAG CTR ABL ON (OFF)	N/A
95	CHNL 13	9	NONE	N/A	N/A
95	CHNL 13	10	(a)	TEST ALARMS ON (OFF)	N/A
95	CHNL 13	11	(a)	ABL CMC STBY ON (OFF)	N/A
95	CHNL 13	12-15	NONE	N/A	N/A
97	CHNL 30	1	(a)	ULLAGE OFF (ON)	N/A
97	CHNL 30	2	(a)	SM SEPARATE OFF (ON)	N/A
97	CHNL 30	3	(a)	SPS READY OFF (ON)	N/A
97	CHNL 30	4	(a)	SIVB SEP/ABT OFF (ON)	N/A
97	CHNL 30	5	(a)	LIFTOFF OFF (ON)	N/A
97	CHNL 30	6	(a)	GUIDNCE REF RL OFF (ON)	N/A
97	CHNL 30	7	(a)	OPT CDU FAIL OFF (ON)	N/A
97	CHNL 30	8	NONE	N/A	N/A
97	CHNL 30	9	(a)	IMU OPERATE OFF (ON)	N/A
97	CHNL 30	10	(a)	S/C CTL SATURN OFF (ON)	N/A
97	CHNL 30	11	(a)	IMU CAGE OFF (ON)	N/A
97	CHNL 30	12	(a)	ISS CDU FAIL OFF (ON)	N/A
97	CHNL 30	13	(a)	IMU FAIL OFF (ON)	N/A
97	CHNL 30	14	(a)	ISS TRNON RQST OFF (ON)	N/A
97	CHNL 30	15	(a)	TEMP IN LIM OFF (ON)	N/A

TABLE 224A-2 (Continued)

WORD NO.	WORD NAME	BIT	DATA MANIPULATION See Notes (-)	DISPLAY	SCALE FACTOR
98	CHNL 31	1	(a)	+PITCH MAN ROT OFF (ON)	N/A
98	CHNL 31	2	(a)	-PITCH MAN ROT OFF (ON)	N/A
98	CHNL 31	3	(a)	+YAW MAN ROT OFF (ON)	N/A
98	CHNL 31	4	(a)	-YAW MAN ROT OFF (ON)	N/A
98	CHNL 31	5	(a)	+ROLL MAN ROT OFF (ON)	N/A
98	CHNL 31	6	(a)	-ROLL MAN ROT OFF (ON)	N/A
98	CHNL 31	7	(a)	+X TRANS OFF (ON)	N/A
98	CHNL 31	8	(a)	-X TRANS OFF (ON)	N/A
98	CHNL 31	9	(a)	+Y TRANS OFF (ON)	N/A
98	CHNL 31	10	(a)	-Y TRANS OFF (ON)	N/A
98	CHNL 31	11	(a)	+Z TRANS OFF (ON)	N/A
98	CHNL 31	12	(a)	-Z TRANS OFF (ON)	N/A
98	CHNL 31	13-14	NONE	N/A	N/A
98	CHNL 31	15	(a)	G/N CONTROL OFF (ON)	N/A
99	CHNL 32	1	(a)	+PITCH MIN IMP OFF (ON)	N/A
99	CHNL 32	2	(a)	-PITCH MIN IMP OFF (ON)	N/A
99	CHNL 32	3	(a)	+YAW MIN IMP OFF (ON)	N/A
99	CHNL 32	4	(a)	-YAW MIN IMP OFF (ON)	N/A
99	CHNL 32	5	(a)	+ROLL MIN IMP OFF (ON)	N/A
99	CHNL 32	6	(a)	-ROLL MIN IMP OFF (ON)	N/A
99	CHNL 32	7-10	NONE	N/A	N/A
99	CHNL 32	11	(a)	LM ATTACHED OFF (ON)	N/A
99	CHNL 32	12-15	NONE	N/A	N/A
100	CHNL 33	1-9	NONE	N/A	N/A
100	CHNL 33	10	(a)	BLOCK UPLINK OFF (ON)	N/A
100	CHNL 33	11	(a)	UPLINK TOO FAST OFF (ON)	N/A
100	CHNL 33	12	NONE	N/A	N/A
100	CHNL 33	13	(a)	PIPA FAIL OFF (ON)	N/A
100	CHNL 33	14	(a)	CMC WARNING OFF (ON)	N/A
100	CHNL 33	15	(a)	OSC ALARM OFF (ON)	N/A

TABLE 224A-2 (continued)

Notes:

a) If the bit indicated equals 1, display the word underlined. If the bit indicated equals 0, display the word parenthesis.

b) If the bit indicated equals 1, set the SCS discrete that displays the word in the display column. If the bit equals 0, remove the appropriate SCS discrete.

c) Display the following:

BIT 4	BIT 5	"XXX" DISPLAY
0	0	OFF
0	1	ZER
1	0	CMC
1	1	MAN

d) Store bit STATUS for G&N 631.

e) Combine the 14 magnitude bits of the most significant part (MS) with 14 magnitude bits of the least significant part (LS). The decimal conversion should be made only after the two parts of the double precision word have been sign checked. The signs appear in bit 15 of each word.

f) Store values of TIME 1, TIME 2 and RANGE TIME for G&N 602.

g) Store bit status for G&N 622A and G&N 632.

h) Store bit status for G&N 631.

i) Treat CDUT as an unsigned 15 bit counter. If $CDUT_8$ is greater than or equal to 61740_8, form $CDUT_8 - 61740_8$, convert to decimal, and multiply by $90°/2^{15}$. Display result as CDUT. If $CDUT_8$ is less than 61740_8, form $CDUT_8 + 61740_8$, convert to decimal and multiply by $90°/2^{15}$. Display result as CDUT.

j) Treat this word as an unsigned 15 Bit counter, convert to decimal and multiply by 360/215.

Title: GC Clock Initialization Program G&N 601

Part Of: Mission Initialization and GC Alignment Program

Purpose: This program sets the GC clock registers TIME 1 and TIME 2 equal to some predetermined preset value at a given Range Time.

The purposes of G&N 601 are as follows:

A. To insert into the GC clock registers a predetermined preset value of time at a given range time.

B. Insert in GC erasable memory a double precision value of Time-to-Epoch, when required.

C. Prepare inputs for G&N 602

NOTE: The uplink transmission (Noun-Verb sequence) format will be the same for the primary and secondary functions of this specification.

Calling Sequence:

A. Enter Range Time (T_{RP}) for insertion of the GC clock preset value by the following C-START entry:

1) Windows 10-9 insert 90
2) Windows 8-7 insert XX hours of T_{RP}
3) Windows 6-5 insert XX minutes of T_{RP}
4) Windows 4-2 insert XXX seconds of T_{RP} (to the nearest tenth)
5) Window 1 insert 0

B. Insert the GC clock preset value as follows:

1) Windows 10-9 insert 91
2) Windows 8-5 insert ±XXX hours of E_p
3) Windows 4-3 insert XX minutes of E_p
4) Windows 2-1 insert XX seconds of E_p

C. Insert the first GC address of the time registers into which the preset value E_p is to be stored, also enter the constant K for G&N 602. This C-START entry is:

1) Windows 10-9 insert 70

2) Windows 8-4 insert YYYYY the 5 digit GC octal address for the time registers.

3) Windows 3-1 insert XXX milleseconds for K.

D. Enter the Epoch time, T_E, that is to be stored in the GC.

1) Windows 10-9 insert 80

2) Windows 8-5 insert ± XXX hours of T_E

3) Windows 4-3 insert XX minutes of T_E

4) Windows 2-1 insert XX seconds of T_E

E. Enter the GC octal address, LOC, into which T_E is to be stored.

1) Windows 10-9 insert 71

2) Windows 8-4 insert YYYYY octal address LOC.

3) Windows 3-1 insert 000

F. Call up G&N 601 through the R-START Module specified in the PRPS.

Input Data:

T_{R_1} - Range Time maintained in ACE-S/C computer.

E_p - Preset time to be inserted in GC clock.

T_{RP} - Range time at which E_p is to be inserted.

T_E - Time to Epoch when required.

Normal Exit: Uplink Transmission to the GC and temporary storage of the following quantities.

K - transmission delays to be supplied jointly by AC and G.E.

T_{HRS} - Range time truncated to hrs.

T_{R_1} - Range time

E_p - Preset time

Error Exit: None.

Computation Sequence: The following sequence should occur:

1) When Range Time, T , is equal to T_{RP}, the quantities E_p and the GC address for the time registers are transmitted uplink using the commands listed under Uplink Commands.

2) If LOC is not equal to zero, then the quantities T_E and LOC are transmitted uplink using the commands listed under Uplink Commands.

3) Store the following items for inputs into G&N 602:

T_{R_1} - Range time, which is also equal to T_{RP}

E_p - Preset time

T_{HRS} - The value of T_{R_1}, truncated to hours

K - constant to be used in G&N 602

4) All uplink commands are to be time tagged and filed on the Uplink File Tape.

5) Before the double precision words E_p and T_E are transmitted uplink they must be converted to double precision words which have a least significant bit of 10 millesecond value.

		Key Code Complement	
1	XXXXX	XXXXX	XXXXX
	5 Bit Keycode		5 Bit Keycode

Figure 601-1

Command Uplink: All uplink transmissions per Figure 601-1 will be as follows·

1	10001	01110	10001	(VERB)
1	00010	11101	00010	(2)
1	00100	11011	00100	(4)
1	11111	00000	11111	(NOUN)
1	10000	01111	10000	(0)
1	00001	11110	00001	(1)
1	11100	00011	11100	(ENTER)
1	$0_1 0_1 0_1 0_1 0_1$	$\overline{0_1 0_1 0_1 0_1 0_1}$	$0_1 0_1 0_1 0_1 0_1$	(DIGIT 1, OCTAL ADDRESS)
1	$0_2 0_2 0_2 0_2 0_2$	$\overline{0_2 0_2 0_2 0_2 0_2}$	$0_2 0_2 0_2 0_2 0_2$	(DIGIT 2, OCTAL ADDRESS)
1	$0_3 0_3 0_3 0_3 0_3$	$\overline{0_3 0_3 0_3 0_3 0_3}$	$0_3 0_3 0_3 0_3 0_3$	(DIGIT 3, OCTAL ADDRESS)
1	$0_4 0_4 0_4 0_4 0_4$	$\overline{0_4 0_4 0_4 0_4 0_4}$	$0_4 0_4 0_4 0_4 0_4$	(DIGIT 4, OCTAL ADDRESS)
1	$0_5 0_5 0_5 0_5 0_5$	$\overline{0_5 0_5 0_5 0_5 0_5}$	$0_5 0_5 0_5 0_5 0_5$	(DIGIT 5, OCTAL ADDRESS)
1	11100	00011	11100	(ENTER)
1	$0_1 0_1 0_1 0_1 0_1$	$\overline{0_1 0_1 0_1 0_1 0_1}$	$0_1 0_1 0_1 0_1 0_1$	(DIGIT 1, WORD 1)
1	$0_2 0_2 0_2 0_2 0_2$	$\overline{0_2 0_2 0_2 0_2 0_2}$	$0_2 0_2 0_2 0_2 0_2$	(DIGIT 2, WORD 1)
1	$0_3 0_3 0_3 0_3 0_3$	$\overline{0_3 0_3 0_3 0_3 0_3}$	$0_3 0_3 0_3 0_3 0_3$	(DIGIT 3, WORD 1)
1	$0_4 0_4 0_4 0_4 0_4$	$\overline{0_4 0_4 0_4 0_4 0_4}$	$0_4 0_4 0_4 0_4 0_4$	(DIGIT 4, WORD 1)
1	$0_5 0_5 0_5 0_5 0_5$	$\overline{0_5 0_5 0_5 0_5 0_5}$	$0_5 0_5 0_5 0_5 0_5$	(DIGIT 5, WORD 1)
1	11100	00011	11100	(ENTER)
1	$0_1 0_1 0_1 0_1 0_1$	$\overline{0_1 0_1 0_1 0_1 0_1}$	$0_1 0_1 0_1 0_1 0_1$	(DIGIT 1, WORD 2)
1	$0_2 0_2 0_2 0_2 0_2$	$\overline{0_2 0_2 0_2 0_2 0_2}$	$0_2 0_2 0_2 0_2 0_2$	(DIGIT 2, WORD 2)
1	$0_3 0_3 0_3 0_3 0_3$	$\overline{0_3 0_3 0_3 0_3 0_3}$	$0_3 0_3 0_3 0_3 0_3$	(DIGIT 3, WORD 2)
1	$0_4 0_4 0_4 0_4 0_4$	$\overline{0_4 0_4 0_4 0_4 0_4}$	$0_4 0_4 0_4 0_4 0_4$	(DIGIT 4, WORD 2)
1	$0_5 0_5 0_5 0_5 0_5$	$\overline{0_5 0_5 0_5 0_5 0_5}$	$0_5 0_5 0_5 0_5 0_5$	(DIGIT 5, WORD 2)
1	11100	00011	11100	(ENTER)
1	11001	00110	11001	(KEYBOARD RELEASE)

Verify: Each Uplink Transmission is to be verified via CSR Verify response. A non-verify response should be indicated by a CRT display of "TIME ERROR 1".

Store: T_{R_1}, E_p, T_{HRS}, and K for inputs to G&N 602

CRT Display: "TIME EPOCH XXX HRS XX MINS XX.XXX SECS"

Operator Action: Console Operator: When Clock Initialization Program is desired, perform the C-START entries before R-START call-up of G&N 601 is made. Make sure there is no other major Uplink Activity at this time.

Spacecraft Operator: No activity required.

Uplink Requirements: See COMPUTATION SEQUENCE.

Downlink Requirements: Measurement ID: Not applicable.

Tolerance: Not applicable.

Remarks: Definition of terms used in this subprogram are as follows:

T_{R_1} - Range Time (hrs, mins, secs, ms)

E_p - Preset time for GC clock (hrs, mins, secs, ms)

T_{RP} - Range time at which E_p is to be inserted (hrs, mins, secs, ms).

T_E - Time to Epoch (hrs, mins, secs, ms)

K - Transmission delays (ms)

LOC - Location (octal) of address in erasable GC memory.

T_{HRS} - Range time truncated to Hrs.

Title: GC Time Verification Program G&N 602

Part Of: Mission Initialization and GC Alignment Program

Purpose: This program is designed to align the GC time clock to the Range Time reference. This program calculates the time alignment Δt which is to be added algebraically to the GC clock register TIME1 and TIME2 to correct for transmission delays in loading and reading these registers.

Calling Sequence: Call-up through the R-START Module specified in the PRPS or PRD.

Inputs:

T_{R_1} = from G&N 601 - Range time of initiation (hrs, mins, secs, ms)

T_{HRS} = Range time truncated to Hrs from G&N 601

K = Transmission delays from G&N 601

E_P = Preset time inserted in GC Clock from G&N 601

T_A = Time from G&N 624 or 224

T_{R_2} = Range Time of GC time receipt

Normal Exit: Display Δt in seconds.

Error Exit: Display error sources as specified.

Computation Sequence:

Compute $\Delta t = (T_{R_2} - T_{R_1}) - (T_A - E_P) - K$

Note: See explanatory flow chart of Δt calculation (Figure 602-1) and explanation of computations in "Remarks" section.

Display: Δt (in seconds, decimal) in the following format:

"DELTA TIME ± XXX.XXX SECS"

Store: Δt as input to G&N 603

Test:

(1) If $|\Delta t| \geq 15$ minutes display "TIME ERROR 2".
If $|\Delta t| < 15$ minutes, continue.

(2) When T_A is sampled for G&N 602 sampling should not occur while the GC time registers in the Downlink Computer memory are being updated.

Since the Range Time is initialized every 24 hours, it is necessary to program a counter which contains the total hours from the initiation of G&N 601. A proposed flow chart for such a routine is given in Figure 602-1.

It should be noted that T_{R_2}, T_{R_1} and T_A can be broken down into units of hours, minutes, seconds and milliseconds. The compare statements in Figure 602-1 use only units of hours which are truncated.

Operator Action:

Console Operator: When time verification program is desired, call up is made through R-START Module activation.

Spacecraft Operator: No activity required.

Uplink Requirements:

Transmission to GC: None

DTCS Stimuli Location: Not Applicable

Time of Transmission: Not Applicable

Downlink Requirements:

Measurement ID: Measurement No. G 0001V

Tolerance:

If program fails Δt test, indicate failure by display indicated under TEST in "Computations" section and return to Uplink Control Program.

Failure of program to execute because of no GC time available should be indicated by "TIME ERROR 4" and exit should be made to Uplink Control Program.

The accuracy of Δt is to be 10 milliseconds.

Filing Requirements:

During System Tests a recording of T_{R_1}, T_{R_2}, E_P, T_A, K, $T_{R_{HRS}}$, $T_{R_{2(HRS)}}$ and DCNT should be made.

Remarks:

Definition of terms used in this subprogram are as follows:

T_{R_1} - Range time from G&N 601 in hrs, mins, secs, ms.

T_{HRS} - Range time from G&N 601 truncated to hrs.

K = Transmission delays from G&N 601 in ms.

E_P = Present Time insert in LGC clock from G&N 601, in hrs, mins, secs, ms.

T_A - GC time from G&N 224 or G&N 624 in hrs, mins, secs, ms.

T_{R_2} - Range time of GC time receipt in hrs, mins, secs, ms.

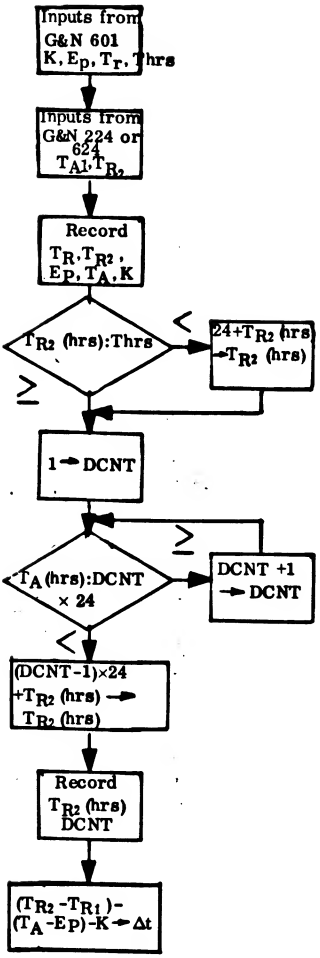

Inputs from G&N 601 K, Ep, Tr, Thrs
Inputs from G&N 224 or 624 TAL, TR2
Record TR, TR2, Ep, TA, K
TR2 (hrs):Thrs
<
24+TR2 hrs →TR2 (hrs)
≥
1 → DCNT
TA (hrs):DCNT × 24
≥
DCNT +1 → DCNT
<
(DCNT-1)×24 +TR2 (hrs) → TR2 (hrs)
Record TR2 (hrs) DCNT
(TR2 -TR1)-(TA -Ep)-K → Δt

Figure 602-1

Title: GC Time Correction G&N 603

Part Of: Mission Initialization and GC Clock Alignment Program

Purpose: This program adds, algebraically, the differential time correction, Δt, to the GC clock to align it to Range Time. This program formats and transmits through the GC Uplink the Δt which is then added to the GC to complete the alignment. G&N 601 and 602 must have been successfully executed before G&N 603 is executed.

Calling Sequence: Entry: Call-up through the R-START Module specified in the PRPS or PRD.

Input: Δt from G&N 602

Normal Exit: Display Δt as per G&N 602. Return to Uplink Control Program.

Error Exit: Display "TIME ERROR 3" to indicate Δt not transmitted or incorrectly transmitted.

Computations Sequence:

1) Transmit Δt by the following Uplink Transmission. The format of the GC Uplink Transmission is given in Figure 603-1.

	Keycode Complement		
XXXXX	$\overline{\text{XXXXX}}$	XXXXX	
5 Bit Keycode		5 Bit Keycode	

Figure 603-1. LGC UPLINK FORMAT

1	10001	01110	10001	(VERB)
1	00101	11010	00101	(5)
1	00101	11010	00101	(5)
1	11100	00011	11100	(ENTER)
1	SIGN	$\overline{\text{SIGN}}$	SIGN	(SIGN OF Δt)
1	$0_1 0_1 0_1 0_1 0_1$	$\overline{0_1 0_1 0_1 0_1 0_1}$	$0_1 0_1 0_1 0_1 0_1$	(1st DIGIT OF Δt)
1	$0_2 0_2 0_2 0_2 0_2$	$\overline{0_2 0_2 0_2 0_2 0_2}$	$0_2 0_2 0_2 0_2 0_2$	(2nd DIGIT OF Δt)
1	$0_3 0_3 0_3 0_3 0_3$	$\overline{0_3 0_3 0_3 0_3 0_3}$	$0_3 0_3 0_3 0_3 0_3$	(3rd DIGIT OF Δt)
1	$0_4 0_4 0_4 0_4 0_4$	$\overline{0_4 0_4 0_4 0_4 0_4}$	$0_4 0_4 0_4 0_4 0_4$	(4th DIGIT OF Δt)
1	$0_5 0_5 0_5 0_5 0_5$	$\overline{0_5 0_5 0_5 0_5 0_5}$	$0_5 0_5 0_5 0_5 0_5$	(5th DIGIT OF Δt)
1	11100	00011	11100	(ENTER)
1	11001	00110	11001	(KEYBOARD RELEASE)

Verify: Each Uplink Word Transmission by using appropriate Uplink Verification Program. Indicate transmission failure by CRT display "TIME ERROR 3".

Operator Action:

Console Operator: When G&N 603 is desired, call-up is made through R-START Module activation.

Spacecraft Operator: No activity required.

Uplink Requirements:

See "Computations" Sequence.

DTCS Stimuli Location: not applicable

Time of Transmission: no requirement

Filing Requirements: All information transmitted should be recorded on Uplink Command File Tape.

Downlink Requirements:

Measurement ID: not applicable.

CRT Display: See Exits under Calling Sequence.

Processing Category: See Program No. G&N 602

Remarks: This mode requires previous calculation of Δt by G&N 602. The sign and five most significant digits are transmitted uplink.

Title: Guidance Computer Downlink Format Program G&N 621

Part Of: Downlink Program

Purpose: The LGC transmits blocks of five 8-bit words into the PCM T/M at a 50 block per second rate. These data blocks represent a complete cycle through one LGC Downlist. The Downlist consists of a fixed length of 100 LGC words, each data block representing 2 of these words. Several lists are specified for LEM Block II, where the list address contained in the ID word identifies the transmitted parameters.

The Downlink Format subprogram accepts each block of five 8-bit words, verifies parity, and reformats each word into a 16-bit format. The type of LGC word represented is identified and the word is routed to other ACE-S/C subprograms for subsequent processing.

Calling Sequence: Entry: This subprogram operates under Downlink Executive Program control and is initiated by receipt of an Executive program interrupt.

Data: 1) A sequence of 50 blocks of five 8-bit words during 1 second.

2) Notification upon loss of a block (prime frame) or sequence of 50 blocks (sub-frame).

Normal Exit: Valid data is transmitted to the appropriate ACE-S/C subprogram for further processing and display.

Error Exit: Error conditions will be displayed on the CRT and recorded on the Downlink file tape. A search for an ID word to enable further data processing, occurs under certain error conditions. The CRT error displays are detailed in Table 621-2.

Computation Sequence:

The program receives blocks of five 8-bit words, configured as follows:

WORD 1	WOC	S/15	14	13	12	11	10	9
WORD 2	8	7	6	5	4	3	2	1
WORD 3	P	S/15	14	13	12	11	10	9
WORD 4	8	7	6	5	4	3	2	1
WORD 5	P	X	X	X	X	X	X	X

where WOC = Word order code (1 bit)
P = Odd parity (LGC word)
X = 0 as presently configured

The data block contains 2 LGC 16-bit data or DSPTAB words, except where an ID word is encountered. The individual word formats are specified below. The LGC data word includes a parity (P) and sign (S) bit. (See Figure 621-1.

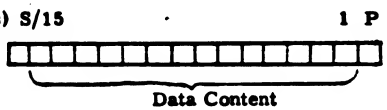
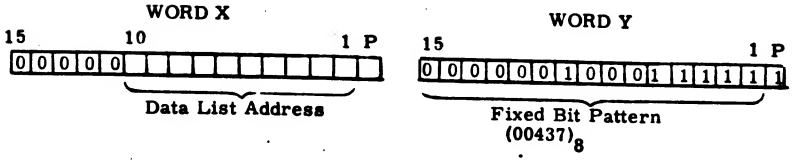


Figure 621-1

The DSPTAB word format is essentially as specified in Figure 621-1, as far as this program is concerned.

The identification (ID) word format contains five leading zeros with bits 1-10 containing the data list address. The complete ID word format is:



Word X precedes Word Y in the data block transmittal (Word 1 - Word 5). The Word order code (WOC) bit contains a 1 for all data and DSPTAB words, and a 0 for the ID word. The position of the LGC word in the fixed length list determines whether the word is to be processed for data monitoring or for DSKY display monitoring. Table 621-1 contains the specified Downlink lists which initiate the operation of this program.

Basically, Program G&N 621 receives PCM data blocks, checks parity, and determines the word type, to allow the transfer of 16-bit words to ACE-S/C programs for subsequent processing. A word count is utilized to detect any deviation from the normal list transmission. A block count is also utilized to indicate if both words in the data block have been processed and so allow the reading in of another block.

When an error is sensed, display and recording of pertinent information takes place and depending upon the type of error, control is transferred to point C in the flow chart (Figure 621-2) where a search for an ID word is initiated.

If a DSPTAB word is detected, then bit 15 is checked for a '1' indication. If a '1' is encountered the word must be complemented prior to transmitting the word to G&N 622 for further processing. Upon detection of an ID word, the data list address is transmitted to G&N 624 to allow that program to utilize the correct display format and scaling information. Figure 621-2 is given as a representative flow, to convey the intent of the subprogram operation.

Operator Action: Console Operator: No activity required.

Spacecraft Operator: No activity required.

Uplink Requirements: Not applicable

Downlink Requirements: Filing: Upon detection of an error the appropriate information is recorded on the Downlink file tape as specified in the flow chart and Table 621-2. (Applicable until the Downlink File capability is removed.)

Display: This information is detailed in the flow chart and consists of program error displays as specified in Table 621-2. The ACE requirements specification contains the CRT page and line information.

Table 621-1

BASIC DOWNLIST FORMAT FOR LEM BLOCK II

WORDCNT	DATA	Five-Word BLOCK	WORDCNT	DATA	Five-Word BLOCK
1 and 2	ID	1	87 88	DSPTAB +8 DSPTAB +9	44
3 - 76	37 DP words, the data contents of which are specified by the ID list address	2 - 38	89 90	DSPTAB +10 DSPTAB +11	45
77 78	UPLOCK T6LOC	39	91 92	TIME 2 TIME 1	46
79 80	DSPTAB +0 DSPTAB +1	40	93 94	(Channel 11) (Channel 12)	47
81 82	DSPTAB +2 DSPTAB +3	41	95 96	(Channel 13) (Channel 14)	48
83 84	DSPTAB +4 DSPTAB +5	42	97 98	(Channel 30) (Channel 31)	49
85 86	DSPTAB +6 DSPTAB +7	43	99 100	(Channel 32) (Channel 33)	50

Four ID groups shall be accepted as valid by this program:

Downlist No.	Word 1_8	Word 2_8
1	00321	00437
2	01610	00437
3	00253	00437
4	00001	00437

Table 621-2 (Continued)

Error Description	CRT Display	File Tape Listing
This indicates that Wordcnt has incremented beyond a specified limit, with no ID word detected.	SYNCERR 1	621, SYNCERR1, Time Tag Reference, WORDCOUNT, 5 word block
At this point Wordcnt should be 101, if an ID has been received in the correct sequence.	SYNCERR 2	621, SYNCERR 2, Time Tag reference, WORDCOUNT, 5-word block.
Parity is incorrect in the first LGC word in data block.	WORDERR 1	621, WORDERR1, Time Tag reference, 5 word block, WORDCOUNT.
Parity is incorrect in the second LGC word in data block.	WORDERR 2	621, WORDERR 2, Time Tag reference, 5 word block, WORDCOUNT.
ID word (bits 11 - 15) $\neq (00)_8$	WORDERR 3	621, WORDERR 3, Time Tag reference, 5 word block, WORDCOUNT.
Fixed bit pattern in ID word is illegal.	WORDERR 4	621, WORDERR 4, Time Tag reference, 5 word block, WORDCOUNT.
Invalid list address encountered after attempting to utilize second LGC word to identify ID word.	WORDERR 5	621, WORDERR 5, Time Tag reference, 5 word block, WORDCOUNT
Invalid list address encountered in the first LGC word in data block.	WORDERR 6	621, WORDERR 6, Time Tag reference, 5 word block, WORDCOUNT.
Parity is incorrect in ID word.	WORDERR 7	WORDCOUNT, 5 word block WORDERR 7, Time tag ref.

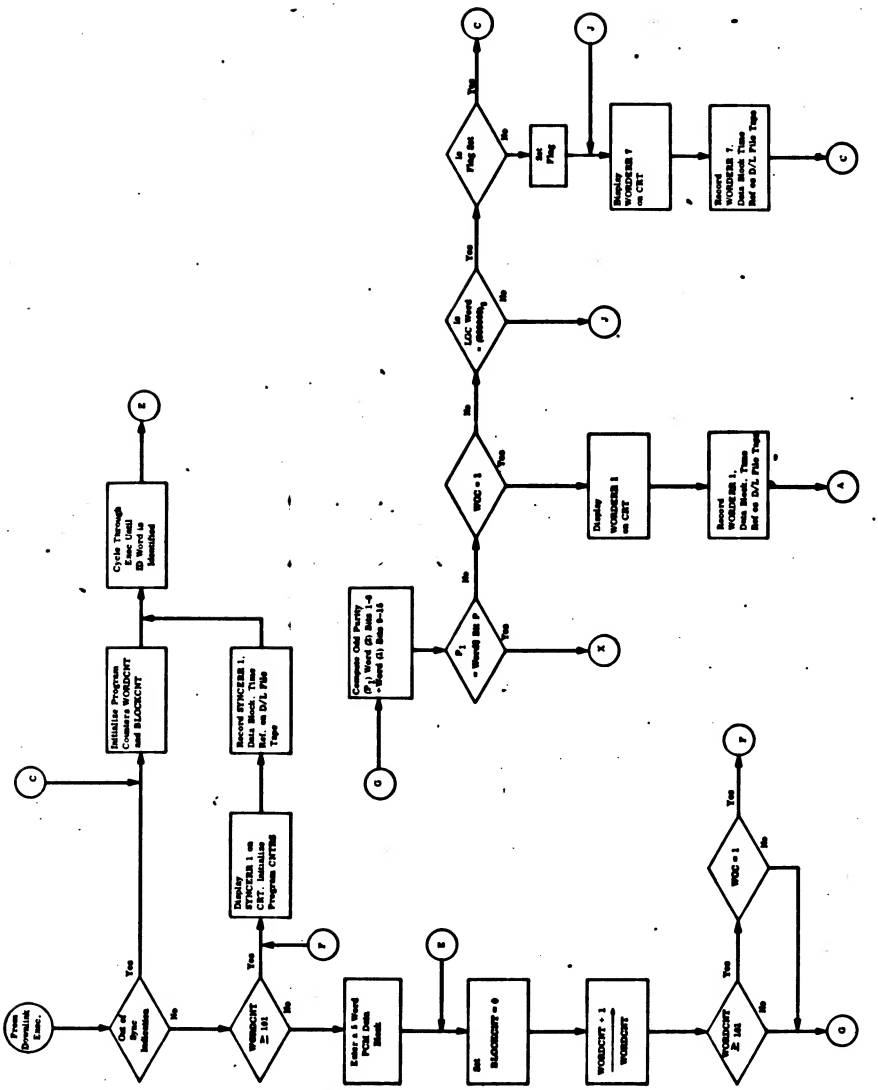


Figure 621-2 (1 of 3)

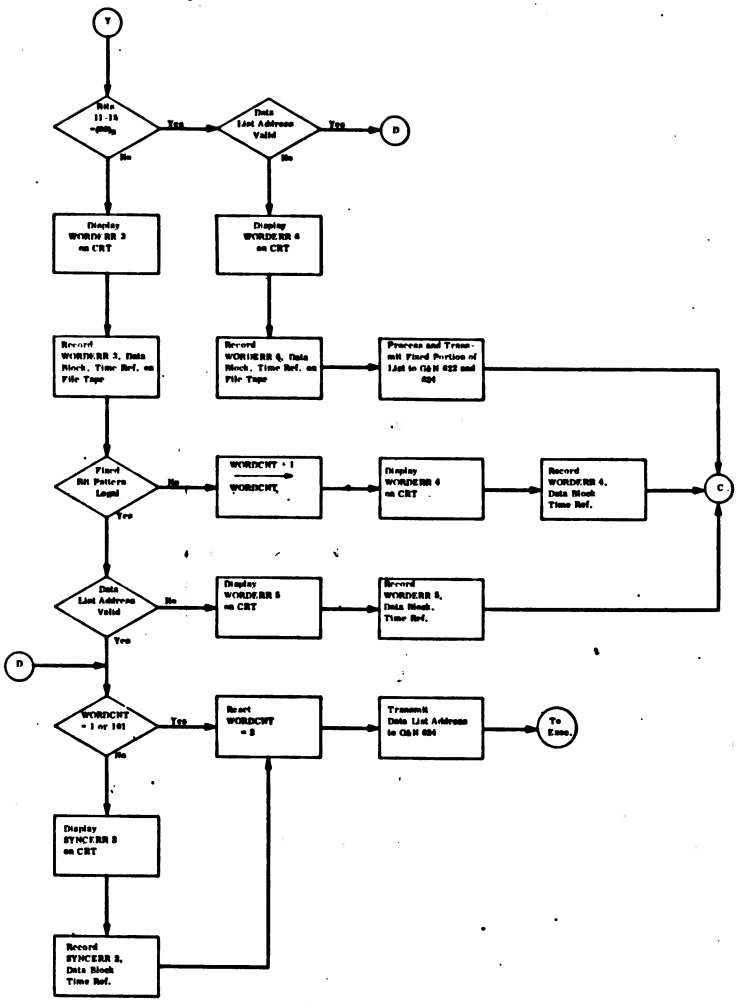


Figure 621-2 (2 of 3)

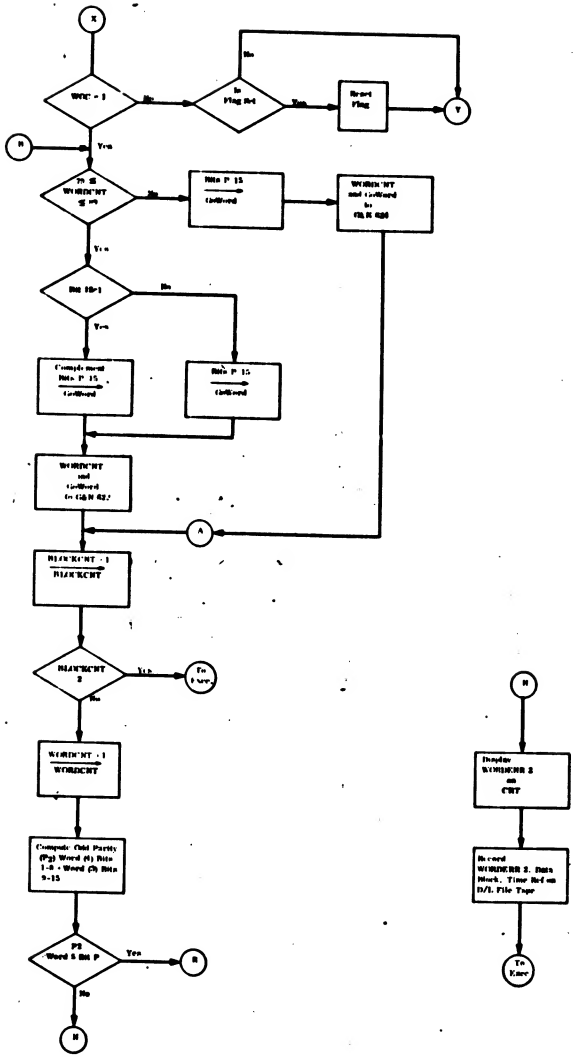


Figure 621-2 (3 of 3)

Title: GC Display Program G&N 622A

Part Of: Downlink Program

Purpose: The GC Display Program interprets all GC Display words that are detected as such by the GC Downlink Format Program G&N X21 and generates CRT displays identical in content and format to the on-board spacecraft displays. This program provides ACE-S/C ground station test personnel the capability of continuously monitoring all spacecraft keyboard displays.

Calling Sequence: Entry: This program is activated only by the GC Downlink Format Program whenever it is processing Downlink data.

Data: Input: Inputs to the display program consist of a complete 16 bit AGC Downlink Display word.

Output: Outputs consist of coded CRT display information which will be available for input to the Symbol Generator System (SGS) memory.

Normal Exit: Normal exit will be a return to the ACE Executive Program so it can provide data for program G&N X21.

Error Exit: Error conditions will cause error information to be displayed on the CRT and recorded on the downlink file tape. After error recording, control is returned to the ACE Executive Program. Error messages are detailed in Table 622A-3.

Computation Sequence: Activation of the GC Display Program is attained via the GC Downlink Format Program, G&N X21. Inputs to this program will be two 8-bit words and a word count value from 79 to 89 inclusive. The word count specifies the position of the display word in the Downlink list which in turn is used to identify the specific format of the display word.

The two 8-bit words constitute a full 16-bit AGC Downlink Display word. The format of this word is shown in Figure 622A-1.

Display Words (Figure 622A-1) consist of four parts of coded information:

1. The address in bits 15-12 is not used in Block II.

Since the display words from the DSPTAB table are sequentially transmitted Downlink, the Downlink Format Program (G&N X21) will supply this subprogram a word count which will properly identify each display word as defined in Table 622A-1.

2. The special code in bit 11 specifies a particular discrete associated with the Display word.

3. Bits 10-6 and 5-1 represent Display Codes which are associated with specific Display Names. These codes specify the numeric character to be displayed according to Table 622A-2.

Example: A Display Word with a bit configuration as shown in Figure 622A-2 and a word count of 83 should cause the ACE Display Program to:

1. Select the Display Word corresponding to associated word count 83 according to Table 622A-1.

2. Set the sign of display register (R2) to plus, according to Table 622A-1.

3. Set digit 1 of display register (R2D1) to 3 according to Table 622A-2.

4. Set digit 2 of display register (R2D2) to 6 according to Table 622A-2.

The Display Program is activated by G&N X21 whenever display words are to be interpreted. Upon entry from G&N X21 the display program switches on the word count value to determine which of the 11 display words is to be interpreted and displayed.

Below is a brief description of the action to be taken on these display words. (See Figure 622A-3 for flow diagram).

WORD COUNT from 21	DISPLAY WORD ACTION
81, 87, 88 or 89	The special code bit (bitt 11), of these 4 display words, is meaningless, therefore control is transferred to program region 1.
86	Go to program region 2.
80, 83 or 85	Bit 11 of these display words is interpreted as follows:
bit 11 = 1	Set sign indicator of R to plus.
bit 11 = 0	Do not change the sign indicator of R.

WORD COUNT from 621	DISPLAY WORD ACTION
79, 82 or 84	Bit 11 of these display words is interpreted as follows:
bit 11 = 1	Set sign indicator of R to minus.
bit 11 = 0	Set sign indicator of R to blank.

In both cases the program continues to region 1.

NOTE: Words with word counts 84 and 85 set the sign of R1; words with word counts 82 and 83 set the sign of R2; words with word counts 79 and 80 set the sign of R3.

Region 1 - extracts the relay code corresponding to bits 10-6 of the Downlink word and checks it against Table 622A-2 for legality. If the code is legal the indicator is set to display the digit from Table 622A-2 followed by a transfer to Region 2. If the code is not legal clear the sign display indicator and initiate a relay-error exit.

Region 2 - extracts the relay code corresponding to bits 5-1 and checks it against Table 622A-2 for legality. If the code is legal the indicator is set to display the digit from Table 622A-2 followed by a return to the ACE Executive Program. If the code is not legal clear the sign and first digit display indicators and initiate a relay-error exit.

Filing Requirements: (Applicable until the Downlink File Capability is removed.)

Upon detection of an error the appropriate records should be made on the file tape. These are given in Table 622A-3.

An R-START is to be used to transcribe the entire display on the file tape. This R-START will be interrogated after the processing of the 11th display word (word count = 89). If the R-START is selected and the display has changed since the last recording, the entire display is to be recorded (including FLASH and UPLINK indicators). If either the R-START is not selected or the display has not changed, no recording should be made. The recording should be prefaced by '622A Display Recording'.

Display Requirements: The CRT Displays required in error conditions are given in Table 622A-3. They and the DSKY CRT displays will be formatted on the pages defined in the ACE Requirements Specification.

16 BIT GC DOWNLINK DISPLAY WORD

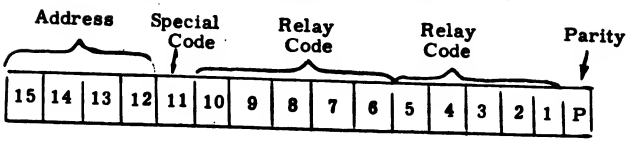


Figure 622A-1

DISPLAY WORD EXAMPLE

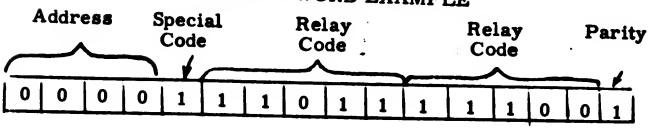


Figure 622A-2

Table 622A-1

Table of DISPLAY Words

Associated Word Count	Address Bits 15-12 Binary Code	Special Code Bit 11	Display Name Relay Code for Bits 10-6	Display Name Relay Code for Bits 5-1
89	N	--	MD1	MD2
88	O		VD1	VD2
87	T	--	ND1	ND2
86			--	R1D1
85	U	+ R1	R1D2	R1D3
84	S	- R1	R1D4	R1D5
83	E	+ R2	R2D1	R2D2
82	D	- R2	R2D3	R2D4
81		--	R2D5	R3D1
80		+ R3	R3D2	R3D3
79		- R3	R3D4	R3D5

Table 622A-2

5 Bit Relay Codes for Numeric Character Display

BLANK	00000
0	10101
1	00011
2	11001
3	11011
4	01111
5	11110
6	11100
7	10011
8	11101
9	11111

Table 622A-3

ERROR DESCRIPTION

ERROR	CRT DISPLAY	STANDARD MESSAGE ON FILE TAPE
A word has appeared containing a relay code which is not in Table 622A-2	RELERR1	622A RELERR1, 16-bit word, time tag, and ID code

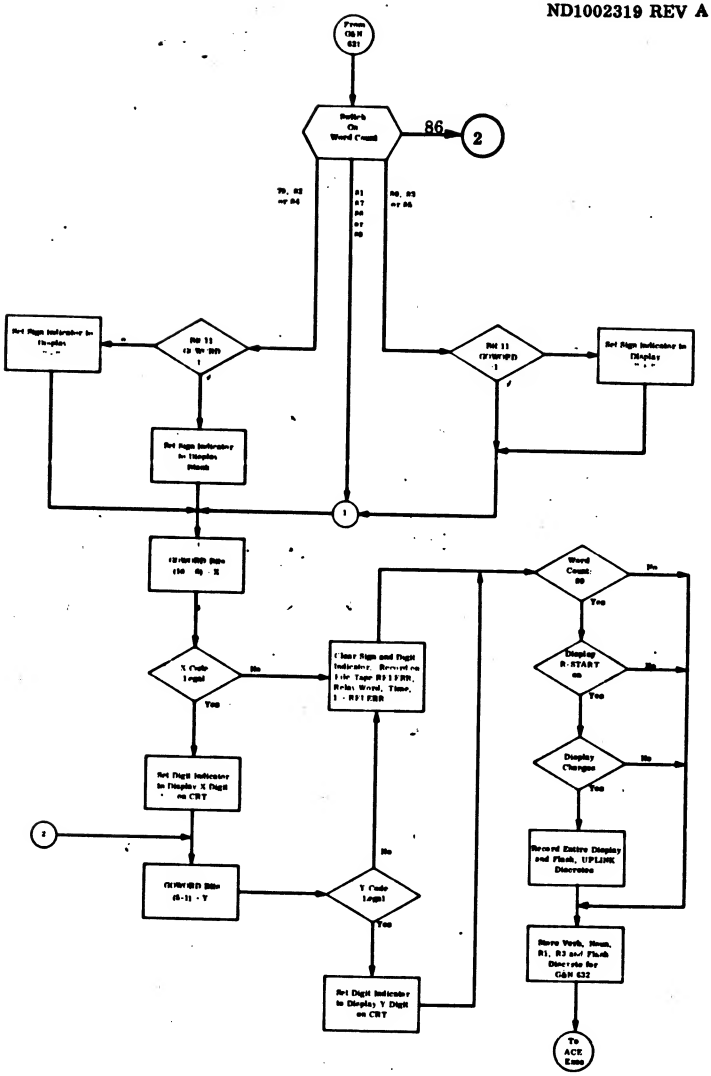


Figure 622A-3

Title: LGC Downlink Interpretation Program, LEM G&N 624A

Part Of: Downlink Program

Purpose: This subprogram defines the interpretation of the LGC Downlink Data which is required for ACE-S/C console operator usage and information. Four downlists are to be processed by this subprogram for post-installation testing. The second word of the identification group for all downlists is identical, i.e., 00437_8. Lists with a first ID word of 00321_8 or 01610_8 shall be processed entirely as described in Table 624A-1. For lists with the first ID word 00253_8 or 00001_8, words 3 through 76 should not be processed, but words 1, 2, and 77 through 100 should be processed as described in Table 624A-1.

Calling Sequence: Entry: This subprogram is activated by the LGC Downlink Format Program, G&N 621, whenever the format Program is processing Downlink Data.

Data Input: Input from G&N 621 to the Downlink Interpretation Program consists of a 16-bit LGC Downlink Data Word. Two types of LGC words will be processed by G&N 624:

1) Identification: This word specifies the data list which is being received by G&N 624.

2) Data: Actual LGC data words. The position in the list identifies the data being processed.

Data Output: Output will consist of CRT displays and processed parameters stored in temporary buffers for use by other ACE-S/C G&N Subprograms.

Normal Exit: Return to ACE Executive Program which will supply more data to G&N 621.

Error Exit: None.

Computation Sequence: The downlink list for the LGC is transmitted once per second and consists of 100 words (two per prime frame). Each prime frame consists of five 8-bit PCM words which contain a 1-bit word order code, two 16-bit LGC words and seven extra (0) bits:

		BIT						
WORD 1	WOC	S/15	14	13	12	11	10	9
WORD 2	8	7	6	5	3	3	2	1
WORD 3	P	S/15	14	13	12	11	10	9
WORD 4	8	7	6	5	4	3	2	1
WORD 5	P	0	0	0	0	0	0	0

The Word Order Code (WOC) is 0 for an ID word and 1 for data words.

P is a Parity Bit

S is a Sign Bit

Table 624A-1 describes the contents of the list and provides the processing requirements for each word.

Operator Action: None

Uplink Requirements: None

Downlink Requirements: CRT Display: The ACE-S/C Programming Requirements Documents contain the CRT scope and line information associated with displays referenced in this subprogram specification.

Filing Requirements: None.

TABLE 624A-1

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION See Note ()	DISPLAY	SCALE FACTOR
1	ID	1-15	Display in OCTAL	IDWD1 XXXXX	N/A
2	ID	1-15	Display in OCTAL	IDWD2 XXXXX	"
3	PIPA X	1-15	Convert to Decimal	PIPA X ± XXXXX	1
4	PIPA Y	1-15	" " "	PIPA Y ± XXXXX	1
5	PIPA Z	1-15	" " "	PIPA Z ± XXXXX	1
6	RHCP	1-15	None	N/A	N/A
7	RADMODES	1	None	N/A	N/A
7	"	2	(b)	IGN RR CDU FAIL ON (OFF)	"
7	"	3	None	N/A	"
7	"	4	(a)	RR DATA FAIL ON (OFF)	"
7	"	5	(a)	LR ALT FAIL ON (OFF)	"
7	"	6-7	None	N/A	"
7	"	8	(a)	LR VEL FAIL ON (OFF)	"
7	"	9-10	None	N/A	"
7	"	11	(a)	RR ANT OUT ON (OFF)	"
7	"	12	(a)	RR ANT MODE 2 (1)	"
7	"	13	(b)	IGN RR CDU FAIL ON (OFF)	"
7	"	14	(a)	RR ANT REMD ON (OFF)	"
7	"	15	(a)	CONT DESIG ON (OFF)	"
8	SAMPLIN	1-15	None	N/A	"
9	OLDAT AGD	"	"	"	"
10	DESCOUNT	"	"	"	"
11	SAMPLSUM	"	"	"	"
12	" + 1	"	"	"	"
13	OPTYHOLD	"	"	"	"
14	" + 1	"	"	"	"
15	TDMEHOLD	"	"	"	"
16	" + 1	"	"	"	"
17	ALTITUDE	"	"	"	"
18	" + 1	"	"	"	"
19	ALTRATE	1-15	Convert to Decimal	ALT RATE ±XXXX.X FPS	0.5 FPS
20	FINALT	1-15	None	N/A	N/A
21	ALTSAVE (MS)	1-15	(c) Convert to Decimal	ALT SAVE ±XXXXXXX.XXX FT	2.345 FT
22	ALTSAVE + 1(LS)	1-15			
23	FINALT (MS)	1-15	(c) Convert to Decimal	FIN ALT ±XXXXXXX.XXX FT	2.345 FT
24	FINALT + 1 (LS)	1-15			
25	FORVEL	1-15	Convert to Decimal	FORVEL ±XXX.XX FPS	0.5571 FPS
26	LATVEL	1-15	Convert to Decimal	LATVEL ±XXX.XX FPS	0.5571 FPS
27	CDUX	1-15	" " "	CDUX ±XXX.XX DEG	$180/2^{14}$ DEG

TABLE 624A-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION (See Note ()	DISPLAY	SCALE FACTOR
28	CDU Y	1-15	Convert to Decimal	CDU Y ±XXX.XX DEG	$180/2^{14}$ DEG
29	CDU Z	1-15	" " "	CDU Z ±XXX.XX DEG	"
30	OPTY	1-15	None	N/A	N/A
31	RR TRUN	1-15	Convert to Decimal	RR TRUN ±XXX.XX DEG	$180/2^{14}$ DEG
32	RR SHAFT	1-15	" " "	RR SHAFT ±XXX.XX DEG	"
33	STATE	1-15	None	N/A	N/A
34	STATE + 1	1-15	"	"	"
35	STATE + 2	1-15	"	"	"
36	STATE + 3	1-15	"	"	"
37	REDO CTR	1-15	Convert to Decimal	REDO CTR XXXXX	1
38	FAIL REG	1-15	Display in Octal	FAIL REG XXXXX	N/A
39	LMPCMD	1-15	" " "	LMPCMD XXXXX	N/A
40	IMODES30	1	(d)	IGN PIP FAIL ON (OFF)	N/A
40	"	2	None	N/A	N/A
40	"	3	(a)	IGN I-CDU FAIL ON (OFF)	"
40	"	4	(a)	IGN IMU FAIL ON (OFF)	"
40	"	5	(d)	IGN PIP FAIL ON (OFF)	"
40	"	6	(a)	INITIALIZE ISS ON (OFF)	"
40	"	7-15	None	N/A	"
41	LAST Y CMD	1-15	None	N/A	"
42	LAST X CMD	1-15	"	"	"
43	TANG	1-15	"	"	"
44	TANG + 1	1-15	"	"	"
45	THETAD	1-15	"	"	"
46	THETAD + 1	1-15	"	"	"
47	THETAD + 2	1-15	"	"	"
48	DELVX	1-15	"	"	"
49	MARKSTAT	1-15	"	"	"
50	XY MARK	1-15	"	"	"
51	DRIFT 0	1-15	Convert to Decimal	VDRIFT 0 ±XXX.XX MERU	$1000/2^{14}$ MERU
52	DRIFT 0 + 1	1-15	None	N/A	N/A
53	DRIFT 1	1-15	Convert to Decimal	SDRIFT 1 ±XXX.XX MERU	$1000/2^{14}$ MERU
54	DRIFT 1 + 1	1-15	None	N/A	N/A
55	DRIFT 2	1-15	Convert to Decimal	EDRIFT 2 ±XXX.XX MERU	$1000/2^{14}$ MERU
56	DRIFT 2 + 1	1-15	None	N/A	N/A
57	TORQUE 0	1-15	None	N/A	N/A
58	TORQUE + 1	1-15	None	"	"
59	ANG Z	1-15	Convert to Decimal	ANG Z ±XXXXX	1.0

TABLE 624A-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION See Note ()	DISPLAY	ERROR FACTOR
60	ANG Z + 1	1-15	None	N/A	N/A
61	ANG Y/PIPA N		Display in Octal	ANG Y/PIPA N XXXXX	"
62	ANG Y + 1		None	N/A	"
63	ANG X/PIPA E		Display in Octal	ANG X/PIPA E XXXXX	"
64	ANG X + 1		None	N/A	"
65	V LAUN		None	N/A	"
66	V LAUN + 1		None	"	"
67	V LAUN + 4		None	"	"
68	V LAUN + 5		None	"	"
69	R STACK (MS)	1-15	(c),(e) Convert to Decimal	RR RANGE ±XXXXXXXXXX.XXX FT	+9.38 FT
70	R STACK + 1 (LS)	1-15		LR VX ±XXXXXXXXX.XXXXX FPS	+0.6435 FPS
71	R STACK + 6 (MS)	1-15	(c),(e) Convert to Decimal	RR RANGE RATE ±XXXXXXXXX.XXXX FPS	+0.6278 FPS
72	R STACK + 7 (LS)	1-15		LR VY ±XXXXXXXXX.XXXXX FPS	+1.2525 FPS
73	R STACK +12D(MS)	1-15	(c) Convert to Decimal	LR VZ ±XXXXXXXX.XXXXX FPS	+0.8571 FPS
74	R STACK +13D (LS)	1-15			
75	R STACK +18D(MS)	1-15	(c) Convert to Decimal	LR ALT ±XXXXXXXXX.XXXXXFT	+1.079 FT
76	R STACK +19D(LS)	1-15			
77	UPLOCK	1	(a)(f)	UPLOCK ON (OFF)	N/A
77	UPLOCK	2-15	None	N/A	N/A
78	T6LOC		None	"	"
79	DSPTAB + 0	1-15	"	"	"
80	DSPTAB + 1	1-15	"	"	"
81	DSPTAB + 2	1-15	"	"	"
82	DSPTAB + 3	1-15	"	"	"
83	DSPTAB + 4	1-15	"	"	"
84	DSPTAB + 5	1-15	"	"	"
85	DSPTAB + 6	1-15	"	"	"
86	DSPTAB + 7	1-15	"	"	"
87	DSPTAB + 8	1-15	"	"	"
88	DSPTAB + 9	1-15	"	"	"
89	DSPTAB + 10	1-15	"	"	"
90	DSPTAB + 11	1-3	None	"	"
90	DSPTAB + 11	4	(a)	NO ATTITUDE ON (OFF)	"
90	DSPTAB + 11	5	None	N/A	"
90	DSPTAB + 11	6	(a)(f)	GIMBAL LOCK ON (OFF)	"
90	DSPTAB + 11	7	None	N/A	"
90	DSPTAB + 11	8	(a)	TRACKER FAIL ON (OFF)	"

TABLE 624A-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION See Note ()	DISPLAY	SCALE FACTOR
90	DSPTAB + 11	9	(a)	PROGRAM ALARM ON (OFF)	N/A
90	DSPTAB + 11	10-15	None	N/A	"
91	TIME 2 (MS)	1-15	(g)(c)	LGC TIME XXXX.XXXXXX	1/360000
92	TIME 1 (LS)	1-15	Convert to Decimal		
93	CHNL 11	1	(a)	ISS WARNING ON (OFF)	N/A
93	"	2	(i)	COMPUTER	"
93	"	3	(i)	UPLINK	"
93	"	4	(a)	TEMP CAUTION ON (OFF)	"
93	"	5	(a)	KEY RELEASE ON (OFF)	"
93	"	6	(a)(h)	FLASH VERB-NOUN ON (OFF)	"
93	"	7	(a)(f)	OPERATOR ERROR ON (OFF)	"
93	"	8-12	None	N/A	"
93	"	13	(a)	ENGINE ON ON (OFF)	"
93	"	14	(a)	ENGINE OFF ON (OFF)	"
93	"	15	None	N/A	"
94	CHNL 12	1	(a)	ZERO RR CDUS ON (OFF)	"
94	"	2	"	RR ERR CNTR ON (OFF)	"
94	"	3	"	HORIZ VEL ON (OFF)	"
94	"	4	"	COARSE ALIGN ON (OFF)	"
94	"	5	"	ZERO ISS CDUS ON (OFF)	"
94	"	6	"	ISS ERR CNTR ON (OFF)	"
94	"	7	"	N/A	"
94	"	8	"	CDU CONTROL ON (OFF)	"
94	"	9	"	+ PITCH TRIM ON (OFF)	"
94	"	10	"	- PITCH TRIM ON (OFF)	"
94	"	11	"	+ ROLL TRIM ON (OFF)	"
94	"	12	"	- ROLL TRIM ON (OFF)	"
94	"	13	"	LR POS2 CMD ON (OFF)	"
94	"	14	"	RR LOCKON ABLE ON (OFF)	"
94	"	15	"	ISS TURNON COMP ON (OFF)	"
95	CHNL 13	1-4	None	N/A	"
95	"	5	(a)	INHIBIT UPLINK ON (OFF)	"
95	"	6-9	None	N/A	"
95	"	10	(a)	TEST ALARMS ON (OFF)	"
95	"	11	(a)	ABL LGC STBY ON (OFF)	"
95	"	12-15	None	N/A	"
96	CHNL 14	1	None	N/A	"
96	"	2	(a)	ALT RATE SEL ON (OFF)	"

TABLE 624A-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION See Note ()	DISPLAY	SCALE FACTOR
96	CHNL 14	3	(a)	ALT METER ACT ON (OFF)	N/A
96	"	4	(a)	THRUST DRV ON (OFF)	"
96	"	5-15	None	N/A	"
97	CHNL 30	1	(a)	ABORT OFF (ON)	"
97	"	2	"	STAGE VERIF OFF (ON)	"
97	"	3	"	ENG ARMED OFF (ON)	"
97	"	4	"	ABORT STAGE OFF (ON)	"
97	"	5	"	AUTO THROT OFF (ON)	"
97	"	6	"	DSP INRTL DATA OFF (ON)	"
97	"	7	"	RR CDU FAIL OFF (ON)	"
97	"	8	None	N/A	"
97	"	9	(a)(f)	IMU OPERATE OFF (ON)	"
97	"	10	(a)	G&N CNTL LEM OFF (ON)	"
97	"	11	"	IMU CAGE OFF (ON)	"
97	"	12	"	ISS CDU FAIL OFF (ON)	"
97	"	13	"	IMU FAIL OFF (ON)	"
97	"	14	"	ISS TURNON RQST OFF (ON)	"
97	"	15	"	TEMP IN LIM OFF (ON)	"
98	CHNL 31	1	(a)	+EL LPD, +PMI OFF (ON)	"
98	"	2	"	-EL LPD, -PMI OFF (ON)	"
98	"	3	"	+YMI OFF (ON)	"
98	"	4	"	-YMI OFF (ON)	"
98	"	5	"	+AZ LPD, +RMI OFF (ON)	"
98	"	6	"	-AZ LPD, -RMI OFF (ON)	"
98	"	7	"	+X TRANS OFF (ON)	"
98	"	8	"	-X TRANS OFF (ON)	"
98	"	9	"	+Y TRANS OFF (ON)	"
98	"	10	"	-Y TRANS OFF (ON)	"
98	"	11	"	+Z TRANS OFF (ON)	"
98	"	12	"	-Z TRANS OFF (ON)	"
98	"	13	"	ATTITUDE HOLD OFF (ON)	"
98	"	14	"	AUTO MODE OFF (ON)	"
98	"	15	"	ATT CMIR DETENT OFF (ON)	"
99	CHNL 32	1	(a)	JETS 2-4 FAIL OFF (ON)	"
99	"	2	"	JETS 5-8 FAIL OFF (ON)	"
99	"	3	"	JETS 1-3 FAIL OFF (ON)	"

TABLE 624A-X (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION See Note ()	DISPLAY	SCALE FACTOR
99	CHNL 32	4	(a)	JETS 6-7 FAIL OFF (ON)	N/A
99	"	5	"	JETS 14-16 FAIL OFF (ON)	"
99	"	6	"	JETS 13-15 FAIL OFF (ON)	"
99	"	7	"	JETS 9-12 FAIL OFF (ON)	"
99	"	8	"	JETS 10-11 FAIL OFF (ON)	"
99	"	9	"	PITCH GIM OFF (ON)	"
99	"	10	"	ROLL GIM OFF (ON)	"
99	"	11-15	None	N/A	"
100	CHNL 33	1	None	N/A	"
100	"	2	(a)	RR ON/AUTO OFF (ON)	"
100	"	3	"	RR RANGE LO-SC OFF (ON)	"
100	"	4	"	RR DATA GOOD OFF (ON)	"
100	"	5	"	LR ALT D GOOD OFF (ON)	"
100	"	6	"	LR POS 1 OFF (ON)	"
100	"	7	"	LR POS 2 OFF (ON)	"
100	"	8	"	LR VEL D GOOD OFF (ON)	"
100	"	9	"	LR ALT LO-SC OFF (ON)	"
100	"	10	"	BLOCK UPLINK OFF (ON)	"
100	"	11	"	UPLINK TOO FAST OFF (ON)	"
100	"	12	None	N/A	"
100	"	13	"	PIPA FAIL OFF (ON)	"
100	"	14	"	LGC WARNING OFF (ON)	"
100	"	15	"	OSC ALARM OFF (ON)	"

TABLE 624A-1 (Continued)

NOTES:

N/A - Not Applicable.

(a) - If the bit indicated equals one, display the word underlined. If the bit indicated equals zero, display the word in parentheses.

(b) - If either bit equals one, display the word underlined. If both bits are zero, display the word in parentheses.

(c) - Combine the 14 magnitude bits of the most significant (MS) part with 14 magnitude bits of the least significant part(LS). The decimal conversion should be made only after the two parts of the double precision word have been sign checked. The signs appear in bit 15 of each word. See "Remarks" for a method for handling double precision words.

(d) - Same as (b).

(e) - NOTE: This double precision word must be scaled two ways each of which is displayed.

(f) - Store bit status for G&N 631.

(g) - Store values for G&N 602.

(h) - Store bit status for G&N 622 and 632. If the indicated bit is a one, set the SGS Discrete for VERB-NOUN FLASH. If the bit is zero, clear the discrete.

(i) - If the bit indicated equals one, set the SGS Discrete that displays the word in the display column. If the bit equals zero, remove the appropriate SGS Discrete.

REMARKS:

Method of Handling Double Precision LGC Downlink Words

Figure 624A-1 is a flow diagram of a scheme for handling the double precision (DP) LGC downlink words. Each word consists of a sign bit (the high order bit), fourteen data bits and a parity bit (low order bit) for odd parity. The downlink words A and B may be in one of four conditions; plus zero (00000_8), minus zero (77777_8), positive non-zero or negative non-zero.

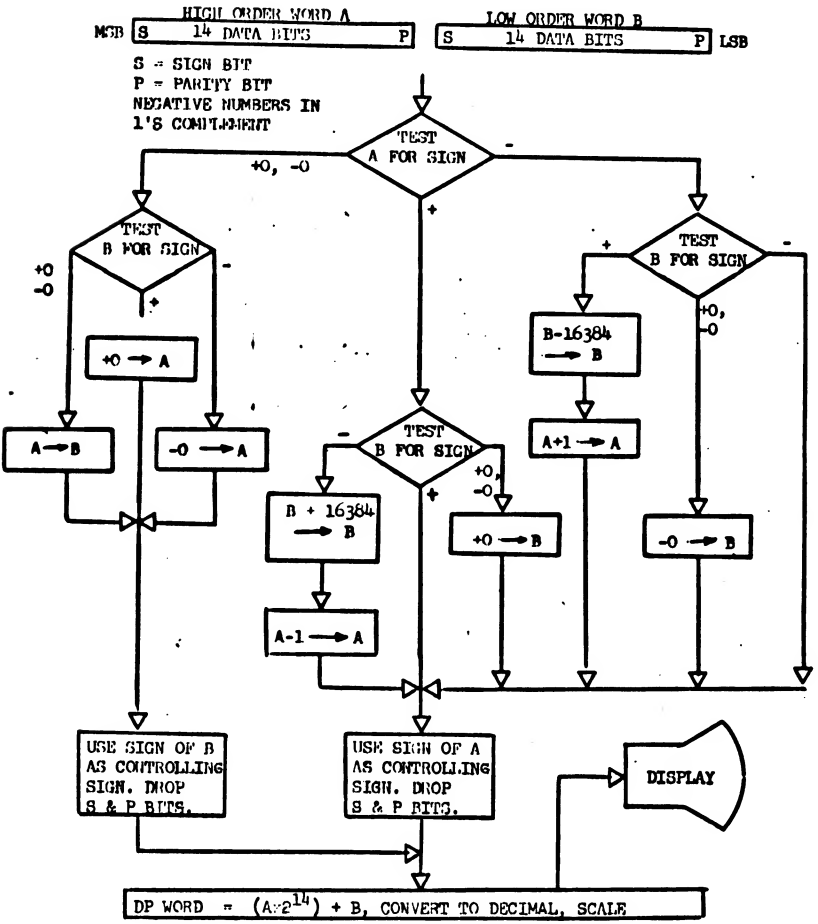
Tests are made on the sign and magnitude of A, and depending on the results, similar tests are made on B as outlined in Figure 624A-1. In the cases where A is plus or minus zero, the sign of B shall be the controlling sign.

In cases where A is non-zero and B is of opposite sign, the conversions to A and B are made as shown in Figure 624A-1, thereby forcing the sign of B to agree with the sign of A.

Prior to combining the DP words into a single quantity, the S and P bits are dropped. Converted B is then added to converted A X 2^{14}, and the resulting 28 bit word is converted to decimal, scaled and displayed on CRT with a sign as specified in the flow diagram.

FIGURE 624A-1

METHOD OF HANDLING DOUBLE PRECISION LGC DOWNLINK WORDS



Title: LGC Downlink Interpretation Program G&N 624B

Part Of: Downlink Program

Purpose: This subprogram defines the interpretation of the LGC Downlink Data which is required for ACE-S/C Console operator usage and information. Four downlists are to be processed by this subprogram for post-installation testing. The second word of the identification group for all downlists is identical, i.e., 00437_8. Lists with a first ID word of 00321_8 or 01610_8 shall be processed entirely as described in Table 624B-1. For lists with the first ID word 00253_8 or 00001_8, words 2 through 76 should not be processed, but words 1 and 77 through 100 should be processed as described in Table 624B-1.

Calling Sequence: Entry: This subprogram is activated by the LGC Downlink Format Program, G&N 621, whenever the format Program is processing Downlink Data.

Data Input: Input from G&N 621 to the Downlink Interpretation Program consists of a 16-bit LGC Downlink Data Word. Two types of LGC words will be processed by G&N 624B:

1) Identification: This word specifies the data list which is being received by G&N 624B.

2) Data: Actual LGC data words. The position in the list identifies the data being processed.

Data Output: Output will consist of CRT displays and processed parameters stored in temporary buffers for use by other ACE-S/C G&N Subprograms.

Normal Exit: Return to ACE Executive Program which will supply more data to G&N 621.

Error Exit: None.

Computation Sequence: Table 624B-1 describes the contents of the list and provides the processing requirements for each word.

Operator Action: None.

Uplink Requirements: None.

Downlink Requirements: CRT Display: The ACE-S/C Programming Requirements Documents contain the CRT scope and line information associated with displays referenced in this subprogram specification.

Filing Requirements: Activation of the 'RECORD' R-START module function switch specified in the PRPS or PRD will cause the filing of a time tag and the following:

Octal Words: ID

Event Words: RADMODES, IMODES30, DSPTAB+11, CHNL 11, CHNL 12, CHNL 13, CHNL 14, CHNL 30, CHNL 31, CHNL 32, CHNL 33

Single Precision Words: REDOCTR, CDUX, CDUY, CDUZ, CDUS, CDUT, PIPAX, PIPAY, PIPAZ

Double Precision Words: (TIME 1, TIME 2)

TABLE 624B-1

WORD NUMBER	WORD NAME	BIT (S)	DATA MANIPULATION See Note ()	DISPLAY
1	ID	1-15	CTOCT	IDWD1 XXXX
3	PIPA X	1-15	CTDEC SF = 1	PIPA X ±XXXXX
4	PIPA Y	1-15	CTDEC SF = 1	PIPA Y ±XXXXX
5	PIPA Z	1-15	CTDEC SF = 1	PIPA Z ±XXXXX
6	RHCP	1-15	None	N/A
7	RADMODES	1	None	N/A
7	RADMODES	2	None	N/A
7	RADMODES	3	None	N/A
7	RADMODES	4	(a)	RR DATA FAIL ON ()
7	RADMODES	5	(a)	LR POS FAIL ON ()
7	RADMODES	6-7	None	N/A
7	RADMODES	8	(a)	LR VEL FAIL ON ()
7	RADMODES	9-10	None	N/A
7	RADMODES	11	(a)	RR ANT OUT ON ()
7	RADMODES	12	(a)	RR ANT MODE 2 (1)
7	RADMODES	13	None	N/A
7	RADMODES	14	(a)	RR ANT REMD ON ()
7	RADMODES	15	(a)	CONT DESIG ON ()
8	SAMPLIN	1-15	None	N/A
9	OLDAT AGD	1-15	None	N/A
10	DESCOUNT	1-15	None	N/A
11	SAMPLSUM	1-15	None	N/A
12	SAMPLSUM + 1	1-15	None	N/A
13	OPTYHOLD	1-15	None	N/A
14	OPTYHOLD + 1	1-15	None	N/A
15	TIMEHOLD	1-15	None	N/A
16	TIMEHOLD + 1	1-15	None	N/A
17	ALTITUDE	1-15	None	N/A
18	ALTITUDE + 1	1-15	None	N/A
19	ALTRATE	1-15	CTDEC SF = 0.5 FPS	ALT RATE ± XXXX. X FPS
20	FINALT	1-15	None	N/A

TABLE 624B-1 (Continued)

WORD NUMBER	WORD NAME	BIT (S)	DATA MANIPULATION See Note ()	DISPLAY
21	ALTSAVE (MS)	1-15	(c) SF = 2.345 FT	ALT SAVE ±XXXXXXX. XXX FT
22	ALTSAVE + 1 (LS)	1-15		
23	FINALT (MS)	1-15	(c) SF = 2.345 FT	FIN ALT ±XXXXXXX. XXX FT
24	FINALT + 1 (LS)	1-15		
25	FORVEL	1-15	CTDEC SF = 0.5571 FPS	FORVEL ±XXX. XX FPS
26	LATVEL	1-15	CTDEC SF = 0.5571 FPS	LATVEL ±XXX. XX FPS
27	CDUX	1-15	(k)	CDUX XXX. XX DEG
28	CDUY	1-15	(k)	CDUY XXX. XX DEG
29	CDUZ	1-15	(k)	CDUZ XXX. XX DEG
30	OPTY	1-15	None	N/A
31	RR TRUN	1-15	(k)	RR TRUN XXX. XX DEG
32	RR SHAFT	1-15	(k)	RR SHAFT XXX. XX DEG
33	STATE	1-15	None	N/A
34	STATE + 1	1-15	None	N/A
35	STATE + 2	1-15	None	N/A
36	STATE + 3	1-15	None	N/A
37	REDO CTR	1-15	CTDEC SF = 1	REDO CTR ±XXXXX
38	FAIL REG	1-15	CTOCT	FAIL REG XXXXX
39	LMPCMD	1-15	CTOCT	LMPCMD XXXXX
40	IMODES30	1	(a)	IGN PIP FAIL ON ()
40	IMODES30	2	None	N/A
40	IMODES30	3	(a)	IGN I-CDU FAIL ON ()
40	IMODES30	4	(a)	IGN IMU FAIL ON ()
40	IMODES30	6	(a)	INITIALIZE ISS ON ()
40	IMODES30	7-15	None	N/A
41	LAST Y CMD	1-15	None	N/A
42	LAST X CMD	1-15	None	N/A
43	TANG	1-15	None	N/A
44	TANG + 1	1-15	None	N/A
45	THETAD	1-15	None	N/A

TABLE 624B-1 (Continued)

WORD NUMBER	WORD NAME	BIT (S)	DATA MANIPULATION See Note ()	DISPLAY
46	THETAD + 1	1-15	None	N/A
47	THETAD + 2	1-15	None	N/A
48	DELVX	1-15	None	N/A
49	MARKSTAT	1-15	None	N/A
50	XY MARK	1-15	None	N/A
51	DRIFT 0	1-15	CTDEC SF = $1000/2^{14}$ MERU	VDRIFT 0 ±XXX.XX MERU
52	DRIFT 0 + 1	1-15	None	N/A
53	DRIFT 1	1-15	CTDEC SF = $1000/2^{14}$ MERU	SDRIFT I ±XXX.XX MERU
54	DRIFT 1 + 1	1-15	None	N/A
55	DRIFT 2	1-15	CTDEC SF = $1000/2^{14}$ MERU	EDRIFT T ±XXX.XX MERU
56	DRIFT 2 + 1	1-15	None	N/A
57	TORQUE 0	1-15	None	N/A
58	TORQUE + 1	1-15	None	N/A
59	ANG Z	1-15	CTDEC SF = 1	ANG Z ±XXXXX
60	ANG Z + 1	1-15	None	N/A
61	ANG Y/PIPA N	1-15	CTOCT	ANG Y/PIPA N XXXXX
62	ANG Y + 1	1-15	None	N/A
63	ANG X/PIPA E	1-15	CTOCT	ANG X/PIPA E XXXXX
64	ANG X + 1	1-15	None	N/A
65	V LAUN	1-15	None	N/A
66	V LAUN + 1	1-15	None	N/A
67	V LAUN + 4	1-15	None	N/A
68	V LAUN + 5	1-15	None	N/A
69	R STACK (MS)	1-15	(c), (e) SF = +9.38 FT	RR RANGE ±XXXXXXXXXX.XXX FT
70	R STACK + 1 (LS)	1-15	(c), (e) SF = +0.6435 FPS	LR VX ±XXXXXXXXX.XXX FPS
71	R STACK + 6 (MS)	1-15	(c), (e) SF = +0.6278 FPS	RR RANGE RATE ±XXXXXXXXX.XXX FPS
72	R STACK + 7 (LS)	1-15	(c), (e) SF = +1.2525 FPS	LR VY ±XXXXXXXXX.XXXXX FPS
73	R STACK +12D (MS)	1-15	(c) SF = +0.8571 FPS	LR VZ ±XXXXXXXXX.XXXXX FPS
74	R STACK +13D (LS)	1-15		
75	R STACK +18D (MS)	1-15	(c) SF = +1.079 FT	LR ALT ±XXXXXXXXX.XXXXX FT
76	R STACK +19D (LS)	1-15		

TABLE 624B-1 (Continued)

WORD NUMBER	WORD NAME	BIT (S)	DATA MANIPULATION See Note ()	DISPLAY
77	UPLOCK	1	(a) (f)	UPLOCK ON ()
77	UPLOCK	2-15	None	N/A
78	T6LOCK	1-15	None	N/A
79	DSPTAB + 0	1-15	None	N/A
80	DSPTAB + 1	1-15	None	N/A
81	DSPTAB + 2	1-15	None	N/A
82	DSPTAB + 3	1-15	None	N/A
83	DSPTAB + 4	1-15	None	N/A
84	DSPTAB + 5	1-15	None	N/A
85	DSPTAB + 6	1-15	None	N/A
86	DSPTAB + 7	1-15	None	N/A
87	DSPTAB + 8	1-15	None	N/A
88	DSPTAB + 9	1-15	None	N/A
89	DSPTAB + 10	1-15	None	N/A
90	DSPTAB + 11	1-3	None	N/A
90	DSPTAB + 11	4	(a)	NO ATTITUDE ON ()
90	DSPTAB + 11	5	None	N/A
90	DSPTAB + 11	6	(a) (f)	GIMBAL LOCK ON ()
90	DSPTAB + 11	7	None	N/A
90	DSPTAB + 11	8	(a)	TRACKER FAIL ON ()
90	DSPTAB + 11	9	(a)	PROGRAM ALARM ON ()
90	DSPTAB + 11	10-15	None	N/A
91	TIME 2 (MS)	1-15	(g) (c) SF = 1/360000	LGC TIME XXXX HRS XX MIN XX. XX SEC
92	TIME 1 (LS)	1-15		
93	CHNL 11	1	None	N/A
93	CHNL 11	2	(i)	COMPUTER
93	CHNL 11	3	(i)	UPLINK
93	CHNL 11	4	(a)	TEMP CAUTION ON ()
93	CHNL 11	5	(a)	KEY RELEASE ON ()
93	CHNL 11	6	(h)	FLASH VERB-NOUN ON ()

TABLE 624B-1 (Continued)

WORD NUMBER	WORD NAME	BIT (S)	DATA MANIPULATION See Note ()	DISPLAY
93	CHNL 11	7	(a) (f)	OPERATOR ERROR ON ()
93	CHNL 11	8-12	None	N/A
93	CHNL 11	13	(a)	ENGINE ON ON ()
93	CHNL 11	14	(a)	ENGINE OFF ON ()
93	CHNL 11	15	None	N/A
94	CHNL 12	1	(a) (j)	ZERO RR CDUS ON ()
94	CHNL 12	2	(a) (j)	RR ERR CNTR ON ()
94	CHNL 12	3	(a)	HORIZ VEL ON ()
94	CHNL 12	4	(a) (j)	COARSE ALIGN ON ()
94	CHNL 12	5	(a) (j)	ZERO ISS CDUS ON ()
94	CHNL 12	6	(a) (j)	ISS ERR CNTR ON ()
94	CHNL 12	7	None	N/A
94	CHNL 12	8	(a) (j)	CDU CONTROL ON ()
94	CHNL 12	9	(a)	+ PITCH TRIM ON ()
94	CHNL 12	10	(a)	- PITCH TRIM ON ()
94	CHNL 12	11	(a)	+ ROLL TRIM ON ()
94	CHNL 12	12	(a)	- ROLL TRIM ON ()
94	CHNL 12	13	(a)	LR POS2 CMD ON ()
94	CHNL 12	14	(a)	RR LOCKON ABLE ON ()
94	CHNL 12	15	(a)	ISS TURNON COMP ON ()
95	CHNL 13	1-4	None	N/A
95	CHNL 13	5	(a)	INHIBIT UPLINK ON ()
95	CHNL 13	6-9	None	N/A
95	CHNL 13	10	(a)	TEST ALARMS ON ()
95	CHNL 13	11	(a)	ABL LGC STBY ON ()
95	CHNL 13	12-15	None	N/A
96	CHNL 14	1	None	N/A
96	CHNL 14	2	(a)	ALT RATE SEL ON ()
96	CHNL 14	3	(a)	ALT METER ACT ON ()
96	CHNL 14	4	(a)	THRUST DRV ON ()

TABLE 624B-1 (Continued)

WORD NUMBER	WORD NAME	BIT (S)	DATA MANIPULATION See Note ()	DISPLAY
96	CHNL 14	5-15	None	N/A
97	CHNL 30	1	(a)	ABORT _____ (ON)
97	CHNL 30	2	(a)	STAGE VERIF _____ (ON)
97	CHNL 30	3	(a)	ENG ARMED _____ (ON)
97	CHNL 30	4	(a)	ABORT STAGE _____ (ON)
97	CHNL 30	5	(a)	AUTO THROT _____ (ON)
97	CHNL 30	6	(a)	DSP INRTL DATA _____ (ON)
97	CHNL 30	7	(a)	RR CDU FAIL _____ (ON)
97	CHNL 30	8	None	N/A
97	CHNL 30	9	(a) (f)	IMU OPERATE _____ (ON)
97	CHNL 30	10	(a)	G&N CNTL LEM _____ (ON)
97	CHNL 30	11	(a)	IMU CAGE _____ (ON)
97	CHNL 30	12	(a)	ISS CDU FAIL _____ (ON)
97	CHNL 30	13	(a)	ISS FAIL _____ (ON)
97	CHNL 30	14	(a)	ISS TURNON RQST _____ (ON)
97	CHNL 30	15	(a)	TEMP IN LIM _____ (ON)
98	CHNL 31	1	(a)	+EL LPD, +PMI _____ (ON)
98	CHNL 31	2	(a)	-EL LPD, -PMI _____ (ON)
98	CHNL 31	3	(a)	+YMI _____ (ON)
98	CHNL 31	4	(a)	-YMI _____ (ON)
98	CHNL 31	5	(a)	+AZ LPD, +RMI _____ (ON)
98	CHNL 31	6	(a)	-AZ LPD, -RMI _____ (ON)
98	CHNL 31	7	(a)	+X TRANS _____ (ON)
98	CHNL 31	8	(a)	-X TRANS _____ (ON)
98	CHNL 31	9	(a)	+Y TRANS _____ (ON)
98	CHNL 31	10	(a)	-Y TRANS _____ (ON)
98	CHNL 31	11	(a)	+Z TRANS _____ (ON)
98	CHNL 31	12	(a)	-Z TRANS _____ (ON)
98	CHNL 31	13	(a)	ATTITUDE HOLD _____ (ON)
98	CHNL 31	14	(a)	AUTO STAB _____ (ON)
98	CHNL 31	15	(a)	ATT CNTR DETENT _____ (ON)

TABLE 624B-1 (CONTINUED)

WORD NUMBER	WORD NAME	BIT (S)	DATA MANIPULATION See Note ()	DISPLAY
99	CHNL 32	1	(a)	JETS 2-4 FAIL _____ (ON)
99	CHNL 32	2	(a)	JETS 5-8 FAIL _____ (ON)
99	CHNL 32	3	(a)	JETS 1-3 FAIL _____ (ON)
99	CHNL 32	4	(a)	JETS 6-7 FAIL _____ (ON)
99	CHNL 32	5	(a)	JETS 14-16 FAIL _____ (ON)
99	CHNL 32	6	(a)	JETS 13-15 FAIL _____ (ON)
99	CHNL 32	7	(a)	JETS 9-12 FAIL _____ (ON)
99	CHNL 32	8	(a)	JETS 10-11 FAIL _____ (ON)
99	CHNL 32	9	(a)	PITCH GIM OFF _____ (ON)
99	CHNL 32	10	(a)	ROLL GIM OFF _____ (ON)
99	CHNL 32	11-15	None	N/A
100	CHNL 33	1	None	N/A
100	CHNL 33	2	(a)	RR ON/AUTO _____ (ON)
100	CHNL 33	3	(a)	RR RANGE LO-SC _____ (ON)
100	CHNL 33	4	(a)	RR DATA GOOD _____ (ON)
100	CHNL 33	5	(a)	LR ALT D GOOD _____ (ON)
100	CHNL 33	6	(a)	LR POS 1 _____ (ON)
100	CHNL 33	7	(a)	LR POS 2 _____ (ON)
100	CHNL 33	8	(a)	LR VEL D GOOD _____ (ON)
100	CHNL 33	9	(a)	LR ALT LO-SC _____ (ON)
100	CHNL 33	10	(a)	BLOCK UPLINK _____ (ON)
100	CHNL 33	11	(a)	UPLINK TOO FAST _____ (ON)
100	CHNL 33	12	N/A	N/A
100	CHNL 33	13	(a)	PIPA FAIL _____ (ON)
100	CHNL 33	14	(a)	LGC WARNING _____ (ON)
100	CHNL 33	15	(a)	OSC ALARM _____ (ON)

TABLE 624B-1 (Continued)

NOTES:

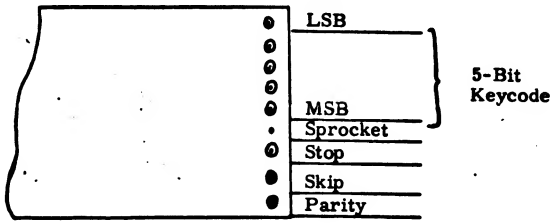
N/A	Not Applicable
CTDEC	Convert the word to decimal considering the word to be a 14 bit number with a sign bit in bit 15 and that if the sign is negative (bit 15 = 1) the 14 data bits are received as the 2's complement.
CTOCT	Convert the 15 bit number to OCTAL
SF	After converting the number to decimal, multiply by the scale factor indicated.
(a)	If the bit indicated equals one, display the word underlined. If the bit indicated equals zero, display the word in parentheses.
(c)	Combine the 14 magnitude bits of the most significant (MS) part with 14 magnitude bits of the least significant part (LS). The decimal conversion should be made only after the two parts of the double precision word have been sign checked. The signs appear in bit 15 of each word. See "Remarks" for a method for handling double precision words.
(e)	NOTE: This double precision word must be scaled two ways, each of which is displayed.
(f)	Store bit status for G&N 631.
(g)	Store values for G&N 602
(h)	Store bit status for G&N 622 and 632. If the indicated bit is a one, set the SGS Discrete for VERB-NOUN FLASH. If the bit is zero, clear the discrete.
(i)	If the bit indicated equals one, set the SGS Discrete that displays the word in the display column. If the bit equals zero, remove the appropriate SGS Discrete.
(j)	These bits must also be displayed as follows: ISS MODE $\underline{X_8}\ \underline{X_6}\ \underline{X_5}\ \underline{X_4}\ \underline{X_2}\ \underline{X_1}$ where X_n is a '0' or '1' for the bit indicated by the subscript.
(k)	Treat this word as an unsigned 15 bit counter, convert to decimal and multiply by $360°/2^{15}$

Title:	K-START Module Program G&N 631
Part Of:	Uplink Program
Purpose:	This subprogram accepts data input in the form of GC keycodes from the punched tape reader or the keyboard, via the K-START module. These keycodes are checked for correct parity and valid codes and then formatted into a command word for eventual transmission to the External DTCS. The status of the Uplink system and the GC is monitored, and the Uplink command sequence is controlled, to the acceptable input rate of the GC.
Calling Sequence:	Entry: This subprogram operates under Uplink Executive Program control and will be initiated from K-START module. Normal Exit: Return to Uplink Executive Program Error Exit: Error conditions will be displayed for the operator on the CRT and recorded on the Command Tape. Those error conditions are subsequently described in Table 631-1.
Data Inputs:	1) The data content utilized by this subprogram consists of a five bit Keycode plus a parity level. The input consists of information received either from K-Start punched tape (Automatic Mode) or from the K-Start Keyboard (Manual Mode). 2) Keycode delay factor of XXX milliseconds entered via C-Start. The format for this input is specified in the PRPS on PRD.

Computation Sequence:

This subprogram is initialized upon operator action by means of the K-START module, either in manual or automatic modes. A five bit keycode (see Table 631-2) as previously mentioned is generated by internal logic upon depression of a keyboard switch or by punched tape input via the tape reader. A transfer to G&N 632 takes place if an R-START module execute is detected.

The format of the paper tape entry is shown below.



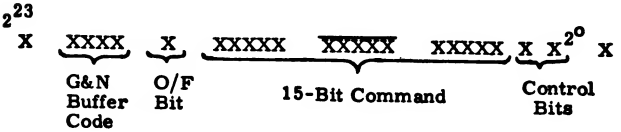
During keyboard entry, the stop and skip positions will contain zeroes and the parity bit is generated internally upon depression of the keyboard switch.

Once a keycode is received by G&N 631, no other data is allowed into this subroutine until so commanded, to ensure that the GC receives Uplink commands at the correct transmission frequency. The keycode is checked with the parity bit to assure that odd parity exists. In the event of a parity error, a CRT display occurs, combined with the "non-verify" lamp display to inhibit further entry through the K-START module. A normal Command Tape recording occurs for post test analysis. If parity is odd, a check is made on the validity of the received keycode, by means of table look-up. A CRT display occurs with a "non-verify" light to indicate an invalid keycode and to inhibit further commands. A normal Command Tape recording occurs for post test analysis.

A valid keycode is then transformed into a 16-bit GC Uplink Word format and combined with the DTCS G&N buffer address

and required control bits as shown below.

G&N UPLINK WORD FORMAT



Prior to transmittal of a sequence of command words, a sequence of tests are made on the incoming keycodes to determine if the command sequence contains a V36. If so, two GC discretes are monitored, namely the "Gimbal Lock" and the "IMU Operate". If both discretes are set to a "one" state, then a "non-verify" display will occur on the K-START and the next keycode will not be transmitted Uplink. Another discrete is monitored, the "Operator Error" flashing discrete (Channel 11, bit 7). An error status will cause this subprogram to terminate the processing of GC commands by inhibiting further K-START data entry with a "non-verify" signal. A normal system recording will occur on the command tape as specified in Table 631-1.

The final discrete tested is GC word UPLOCK, bit 1. A "one" state will result in a test for an "alarm reset" keycode. If this code is available, then two commands will be transmitted at the correct frequency. The first command will zero the GC Uplink register and the second, namely, the "reset" keycode will possibly reset the alarm indication triggered by UPLOCK, bit 1. The "zero" state for this discrete, will allow the subprogram to continue and transmit the commands to the GC with subsequent recordings on the command tape.

The K-START module is sealed after receipt of a keycode, to allow the correct transmission frequency to the GC to be utilized. The sealing can occur as soon as a "good" CSR is received from the DTCS, after which a time delay is utilized to give an approximate maximum input rate to the GC of six keycodes/sec.

A "bad" CSR response should cause the K-START to display a "non-verify" and subsequently be unsealed, to allow further

operator action to be taken. It should be noted at this point, that as the state of the above mentioned discretes can change at a maximum of only once every second, approximately eight commands could be transmitted Uplink before repeating discrete testing. Figure 631-1 is given as a representative flow, to convey the intent of the subprogram operation.

Operator Action:

During the processing of the input keycodes a test is made to determine whether the range time since "Sealing" the K-START module is greater than or equal to the time delay factor entered via C-START. . If so, the verify indication is displayed and the subprogram then transfers control to the Uplink Executive program. If not, the module remains "Sealed" to inhibit further input through the K-START module until the time delay has elapsed. This regulates the input rate of keycodes to the GC. A nominal time delay factor is 90 milliseconds.

Console Operator: Operator action is required to initiate this sub-program by entering data via the K-START module keyboard or tape reader.

When a NON-VERIFY display occurs, further character entry is allowed after depression of the NON-VERIFY switch.

For tape mode of operation enter 3100000XXX into C-START. XXX is the time delay factor in milliseconds.

The operator's responsibility includes the monitoring of displays and the initiation of procedures based upon the display interpretation. Normally the status of the "Accept Uplink" discrete was processed by the K-START module subprogram (G&N 631) prior to transmission of data Uplink. However, this discrete is now permanently wired to give a display of "Accept Uplink On", therefore no testing of this bit by this subprogram (G&N 631) takes place. If the "Operator Error On" condition appears, this subprogram will inhibit data transfer through the K-START with a non-verify. The operator will reset this "non-verify" switch and insert a "reset" keycode to clear the "Operator Error" display. Then correct the illegal data sequence and re-enter through the K-START.

An "UPLOCK bit '" display will again inhibit data transfer through the K-START. The operator will reset the "non-verify" and insert a "reset" keycode to clear the discrete. The subprogram will then transmit a "zero" message followed by the "reset" keycode. This may reset the "UPLOCK" discrete and the operator can continue his interrupted sequence of commands by re-inserting the previous keycode.

Two other conditions cause this subprogram to inhibit data input through the K-START, they are a parity error and an invalid keycode. The operator will release the non-verify and apply corrective measures to the input.

If a "Keyerr 2" CRT display occurs, then the operator should re-insert the "Verb 36 Enter" sequence after monitoring the "Gimbal Lock" and "IMU Operate" discrete displays.

Commands inserted via the keyboard will be verified by means of the "closed loop" display, which depicts the GC DSKY status on the CRT, prior to depression of the "Enter" keycodes. The punched tape input, if visual verification is desired, should contain strategically located "stop" codes in the Verb/Noun and parameter sequences, to allow the operator time to perform verification.

Spacecraft Operator: No activity required.

Uplink Requirements: DTCS Transmission: The data word transmitted to the G&N buffer is identified in the Computation Sequence and will be generated as required.

DTCS Stimuli: None

Transmission Time: During G&N testing this will be specified in the Operational Checkout Procedure. All other times will be as required.

Filing: 1) All K-START command information will be recorded on the command tape.

2) Additional recordings for error conditions and discrete inhibits are specified in Table 631-1.

Downlink Requirements: CRT Displays:

1. The time delay factor in XXX milliseconds and the appropriate nomenclature.

2. Program error displays as specified in Table 631-1.

The Program Requirements Process Specification contains the CRT page and line information.

Remarks: Definition of Flow Chart Symbols

Symbol	Definition
KEYWORD	Contains current keycode to be processed.
ZERCODE	Uplink command to zero the LGC Inlink register for resync purposes.
UPCOM	Contains command word content.
Channel 30 Channel 11 UPLOCK DSPTAB +11	GC Discrete registers, processed by G&N 624A, 624B, or 224A.

Table 631-1

CRT Error Display Definition

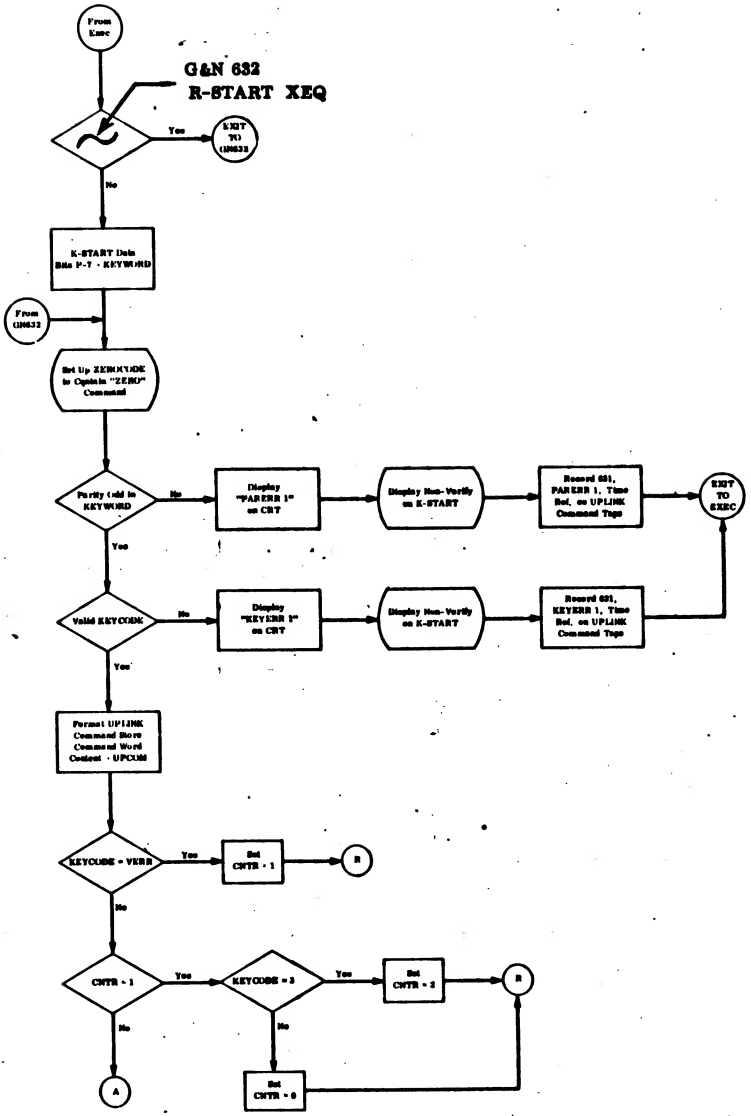
Error or Discrete	CRT Display	K-START Module Display	Command Tape Edit
Odd parity does not exist in the data frame received from K-START module.	PARERR 1	Non-Verify	631, PARERR 1, Time Ref.
An invalid GC keycode has been received by this sub-program.	KEYERR 1	Non-Verify	631, KEYERR 1, Time Ref.
An illegal entry of a V36E has occured.	KEYERR 2	Non-Verify	631, KEYERR 2, Time Ref.
This indicates that an incorrect keycode loading procedure has occeured and entry through the K-START is inhibited.	OPERATOR ERROR ON*	Non-Verify	631, Op. Error, Time Ref.

*These CRT discrete displays are set by G&N 624A or 624B ACE-S/C Downlink Interpretation Program.

Table 631-2

Legal AGC/LGC Keycodes

Character	Code MSB LSB
0	10000
1	00001
2	00010
3	00011
4	00100
5	00101
6	00110
7	00111
8	01000
9	01001
VERB	10001
RESET	10010
KEY RELEASE	11001
PLUS	11010
MINUS	11011
ENTER	11100
CLEAR	11110
NOUN	11111



4-631.9

Figure 631-1 (1 of 3)

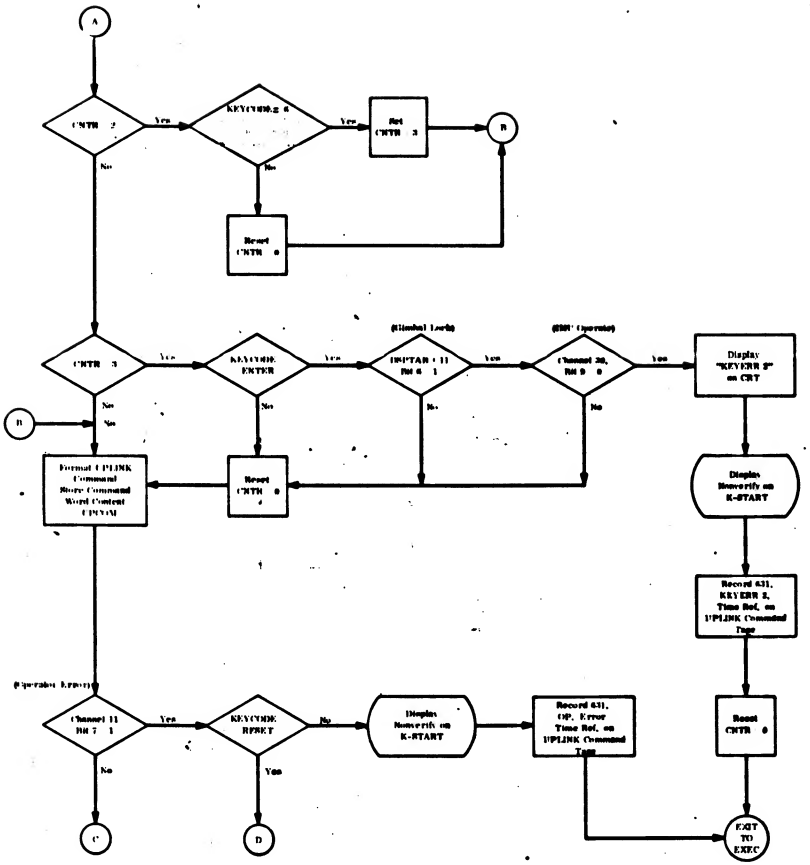


Figure 631-1 (2 of 3)

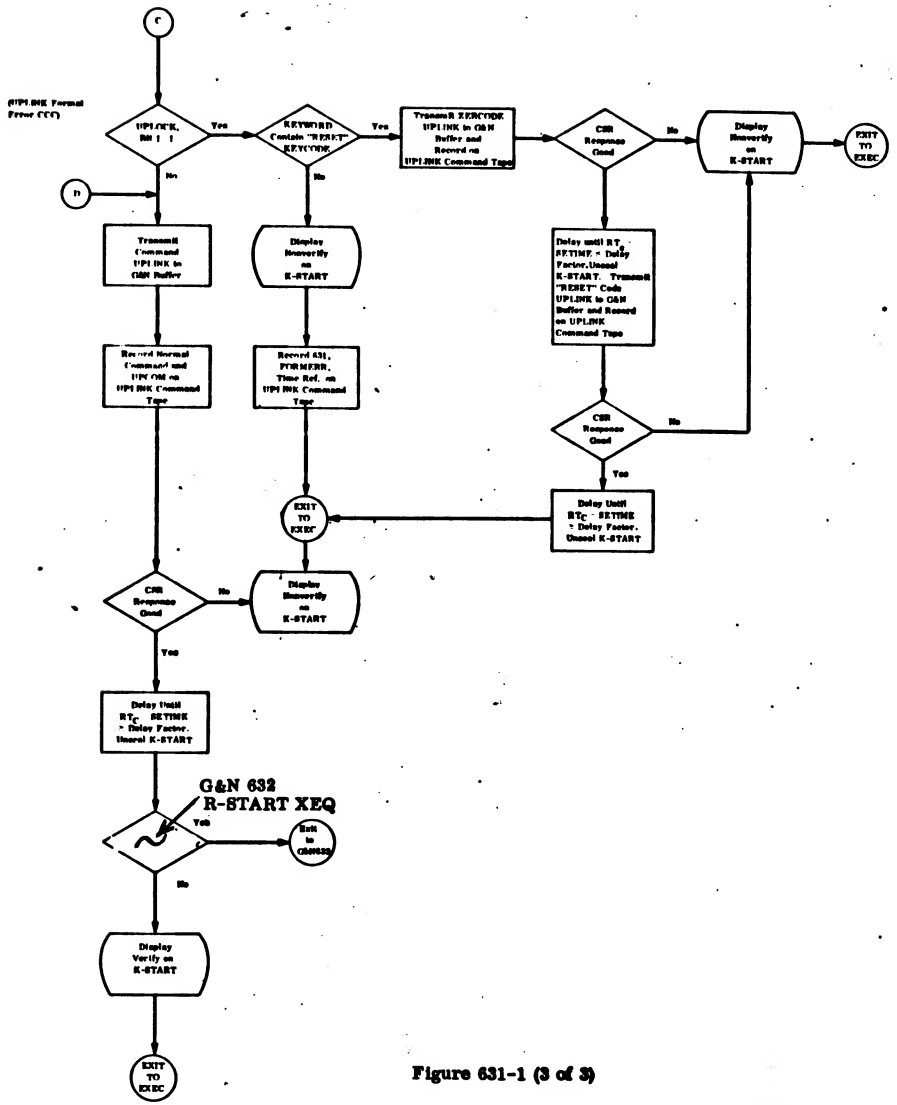


Figure 631-1 (3 of 3)

Title: Special K-Start Load-Verify and Verify Program G&N 632

Part Of: Uplink Program

Purpose: This program is used to check and verify or record the contents of GC erasable memory locations. All data to be verified or recorded is specified on pre-punched K-Start input tapes.

Two options have been provided for verification or recording. Selection of these options is attained through activation of R-Start Module function switches and K-Start.

Calling Sequence: Entry: This program is activated only by the K-Start Module Program (G&N 631), whenever it in turn has been activated and also if the R-Start Module specified in the PRPS or PRD has been executed. Function switches of this R-Start Module specify one of two options used by G&N 632. These are:

1. Load-Verify - Activation of the specified R-Start Module function switch causes G&N 632 to verify that the data being loaded into erasable GC memory locations is identical to the data stored on the K-Start input tape.

2. Verify - Activation of the specified R-Start Module function switch causes G&N 632 to check and verify that the contents of previously loaded and verified GC erasable memory locations have not been altered by internal GC functions or external input means.

Data: This consists of information received from punched K-Start tapes. The data content utilized by this subprogram consists of five bit keycodes plus a parity level.

Normal Exit:

1. Return to G&N 631 whenever keycodes are to be checked for validity and parity and then transmitted to the GC

2. Return to Uplink Executive Program when a complete Special K-Start tape sequence has been processed by G&N 632 and 631.

Error Exit: Error conditions will be displayed on the CRT for operation action.

Computation Sequence:

Activation of this program is attained via the K-Start Module Program, G&N 631 following operator action on the specified R-Start Module and K-Start Module. Execution of the R-Start must occur before K-Start action. The K-Start execute causes the ACE Executive to activate G&N 631 which in turn activates and maintains close interface with G&N 632 provided R-Start Module execution is sensed by G&N 631. If G&N 631 does not detect execution of this R-Start it then treats the K-Start input tape in a normal fashion. The paragraphs below represent a description of the logic contained in the flow diagram shown in Figure 632-1.

Upon entry from G&N 631 various counters and indicators are set to specific values depending on which function switch of the R-Start Module has been executed. G&N 632 then reads the R1 keycode characters into the CDC and seals the K-Start Module. These keycode characters represent the initial VERB-NOUN sequence to be transmitted Uplink.

The format of this "record" is checked for validity. This should be 18 keycode characters for the Load-Verify and Verify tape (the tape format defined in Table 632-1.) Format non-verification results in a CRT error display, K-Start Module release and program control return to ACE Executive. If the Verify option has been selected, the one component load Verb-Noun is changed to one component display Verb-Noun (V21N01 to V01N01).

At this point in the program a loop is set up, based on the value of K1, which loads one keycode at a time into KEY-WORD and allows G&N 631 to perform its normal function of completely verifying each keycode from G&N 632 and transmitting each Uplink. (See G&N 631). After all appropriate keycodes have been transmitted Uplink, the Flash discrete is obtained from the G&N 622 buffer. A test is made on the Flash discrete. If "1" (flashing), G&N 632 delays until the next DSPTAB table is displayed by G&N 622 and repeats the "Flash" test. A third failure in this area should cause an error exit with a CRT error display and a return to ACE Executive.

If the "Flash" discrete is "0" (stop flashing), the program delays until the next DSPTAB table is processed by G&N 622 and obtains the R1, R3, VERB and NOUN values. This delay is to assure G&N 632 that all pertinent GC DSPTAB updated data has been received by the Display Program. Following this delay the Verb-Noun combination for the particular tape option in progress is checked for validity, the input address is compared against the contents of R3 and the input constant is compared against the contents of R1. Any invalid test results in an error exit as specified above.

Following valid testing, G&N 632 releases the K-Start seal, reads one keycode character and checks this code for Key-release. Detection of the Key-release code will result in K-Start module seal and an exit to G&N 631 for Uplink transmission of the Key-release Keycode. When re-entered from G&N 631, the K-Start module is un-sealed, KSEQ "OK" is displayed on the CRT and G&N 632 returns control to the ACE executive. If, however, the first code of the "record" is not Key-release. G&N 632 reads R2-1 keycode characters into the CDC and seals the K-Start Module. These keycode characters represent interim "records" of keycode data necessary for the proper operation of the one parameter Load or Display Verb-Noun combination in the GC. The format of each "record" is tested for validity. An improper format results in an error exit as previously specified. With a legal "record" the program sets up a loop, based on the K2 value, for Uplink Keycode transmission via G&N 631.

Following successful Keycode transmission G&N 632 obtains pertinent data from the G&N#622 buffer and repeats a sequence of testing as specified above.

Operator Action:

Console Operator: To activate G&N 632, the R-Start Module specified in the PRPS or PRD must be executed. Two options are available:

1. One function switch selects the Load-Verify option.
2. The other selects the Verify option.

In addition to the R-Start execute, the K-Start Module must also be activated.

The operator's responsibility also includes the monitoring of displays and the initiation of procedures based upon the display interpretation. Before initiating action to process a Special K-Start tape via G&N 632, the console operator should check and perform the following operations:

1. Depress the NON-VERIFY switch if the non-verify light is on.

2. Check the CRT status of:

Operator Error discrete for "ON"

If any of these conditions exist, Uplink transmission will be inhibited by G & N 631. Recovery Procedures for these conditions are specified in the "K-Start Module Program G & N 631" Computation sequence section.

After verifying that the above conditions have been fulfilled the operator may initiate processing of the Special K-Start tape as prescribed. CRT monitoring should continue during G & N 632 K-START tape processing. Illumination of the NON-VERIFY light will result in the discontinuation of the Special K-Start tape processing. When this occurs, the console operator should record the indicated error in order to initiate corrective procedures. The error displayed will be one of the following:

1. VERROR 1 through VERROR 5 indicates error detection in G &N 632 (See Table 632-2 for definitions.)

2. PARERR 1, KEYERR 1, or Operator Error "ON" indicate error detection in G&N 631.

An error free K-Start tape sequence will result in the CRT display of KSEQ 'OK'.

VERROR Recovery Procedures

One of three operator actions must be taken if G &N 632 detects an error (VERROR type).

1. Re-cycle: This allows a re-run of the present K-Start tape sequence.

 a. Re-load K-Start tape to Verb character.

 b. Re-initiate K-Start action.

2. Continue: This allows tape operation to continue from point of error.

 a. Re-initiate K-Start action.

3. Abort: This terminates processing of the present K-Start tape sequence.

a. Manually insert 'ERROR-RESET' to allow G & N 632 to "unseal" the R-Start module.

Spacecraft Operator:

No activity required.

Uplink Requirements:

DTCS Transmission:

The word transmitted Uplink is identified in the Computation Sequence section of G & N 631.

DTCS Simuli:

None.

Transmission Time:

As required.

Filing:

All K-Start command information will be recorded on the command tape by G & N 631.

Downlink Requirements:

CRT Display:

This information is detailed in the program flow chart and consists of KSEQ 'OK' if no errors occur or program error displays if any are detected by either G & N 632 or G & N 631. If this test is aborted by means of the "ERROR-RESET" code, KSEQ 'NG' will be displayed on the CRT. Error displays are defined in Table 632-2. The ACE Requirements Specification contains the CRT scope page and line information.

Remarks: A definition of terms used in this subprogram is as follows:

1. Flag — Program indicator specifying one of three program options.
2. K1 — Counter which specifies the number of keycodes to be initially transmitted to the GC.
3. K2 — Counter which specifies the number of keycodes to be transmitted to the GC after initial transmission.
4. R1 — Counter which specifies the number of keycode characters to be initially read and processed.
5. R2 — Counter which specifies the number of keycode characters to be read and processed after the initial "record".
6. KEYWORD — Register containing 8 bit keycode for G & N 631 processing.
7. VERROR — Indicator set by G & N 632 whenever errors are encountered. (See Table 632-2.)
8. KSEQ — CRT Indicator set to display 'OK' if a complete Verb-Noun sequence is verified error free. Set to 'NG' if test is aborted due to error detection. Entry to G & N 632 blanks 'NG' or 'OK'.
9. BLKCNT — Value specifies K-Start data block being processed when G & N 632 detects an error. Part of Uplink command tape recording.
10. WDCNT — Value specifies last tape input character which was detected as an error by G & N 632. This word count is used in conjunction with the Block Count value. Part of Uplink command tape recording.

Table 632-1

TAPE FORMATS

Load-Verify and Verify Tape

HEADER
Verb 21 Noun 01 ENTER
4 octal digit address ENTER 5 octal digit constant ENTER ENTER 4 octal digit address ENTER 5 octal digit constant ENTER ⋮ ENTER 4 octal digit address ENTER 5 octal digit constant ENTER
STOP KEYRELEASE

Table 632-2

CRT ERROR DISPLAY DEFINITION FOR G&N 632

Error	CRT Display	K-Start Module Display
Improperly formatted K-Start tape.	VERROR 1	Non-Verify
Flash discrete 'ON'. Load or display Verb-Noun address and/or data values not accepted by GC.	VERROR 2	Non-Verify
DSPTAB Verb-Noun not same as input Verb-Noun.	VERROR 3	Non-Verify
DSPTAB address (R3) does not verify with input address.	VERROR 4	Non-Verify
DSPTAB constant (R1) does not verify with input constant.	VERROR 5	Non-Verify

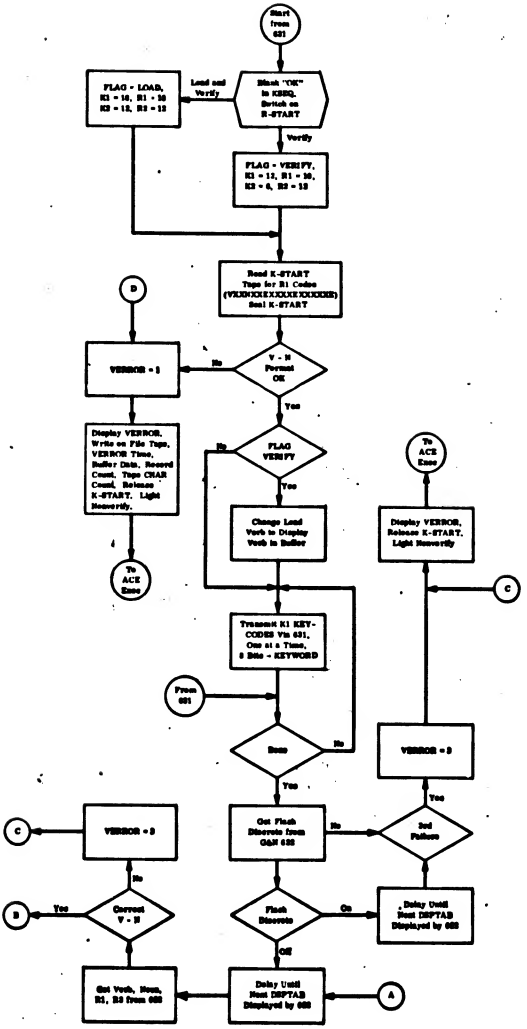


Figure 632-1 (1 of 2)

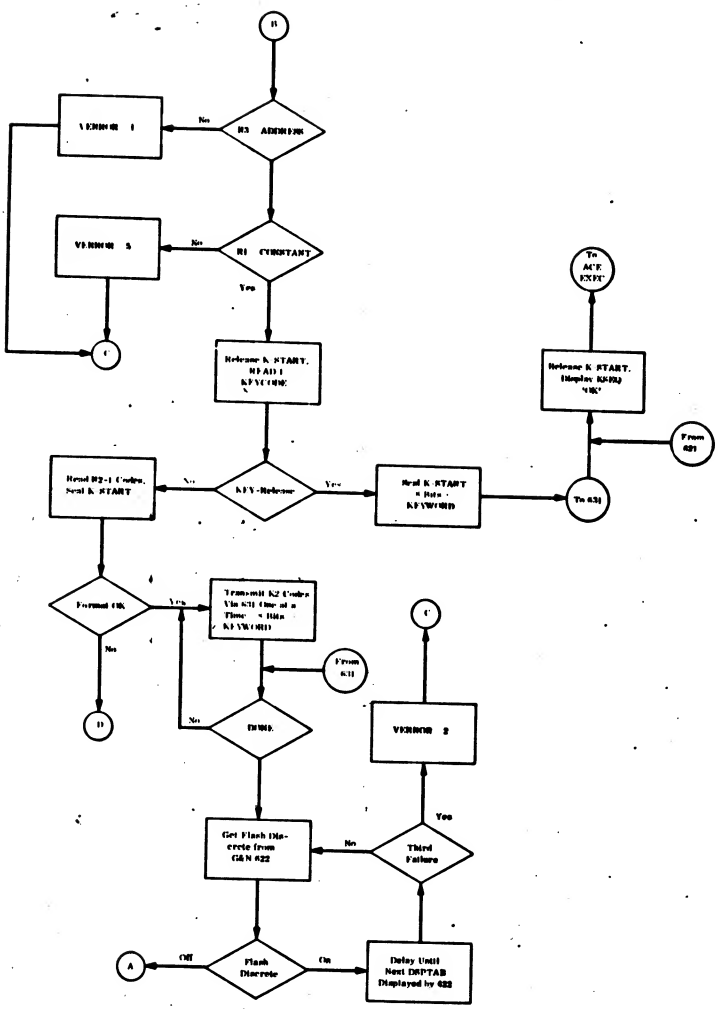


Figure 632-1 (2 of 2)

Title: G&N High Rate Channel Control Program G&N 641

Part Of: Communication Program

Purpose: This program controls the switching of selected signals for transmission over the 400 sample/second high rate sampling channel.

Calling Sequence: Entry: This program will operate under Executive Control and will be initiated from the C-START module specified in the PRPS or PRD.

Data: C-START Module data entry - Window ten (10), eight (8) and seven (7) are set to desired characters.

Normal Exit: Return to Executive Control

Error Exit: None required

Computation Sequence:

This program is entered from the Executive Program when requested by the C-START module. Selector switches eight (8) and seven (7), are utilized for high rate channel selection, while selector switch ten (10) (leftmost selector switch) will be utilized for program identification. Selector switch ten (10) will be tested, and when found to contain the digit two (2), will cause entry into the high rate channel select program. Selector switches eight (8) and seven (7) will be tested to determine which measurement, if any, is being requested. If the code contained in windows eight (8) and seven (7) exceeds the limits of the matrix (i. e. greater than 32 decimal) the program exits to Executive Control. If the code is a valid code, the program tests to determine if the code is the same as tne code for the measurement presently displayed. In the event that the selection has not changed, the

signal selection command is ignored and control is returned to the Executive Program. If the code contained in windows eight (8) and seven (7) is a code for a new measurement, the program will then cause the computer to generate the commands necessary to remove the previously selected signal from the matrix and by energizing one or more of the ten high rate control relays in the DTCS, cause the new signal to be switched onto the 400 S/S channel. The relay assignments will be specified in GAEC or NAA Program Requirements Specification. Figure 641-1 is a representative flow diagram of this subprogram.

Operator Action: Console Operator action is required to initiate this program by C-START selection of the high rate signals. The sequence is as follows:

a. The desired program identification digit (2) is entered into selector switch ten (10).

b. The desired measurement identification digits are entered into selector switches eight (8) and seven (7).

c. The XEQ/SEAL Switch is depressed.

Spacecraft Operator: No activity required.

Uplink Requirements:

GC Transmission: None

Time of Transmission: Not defined

Filing Requirements: Measurement ID, time tag

Downlink Requirements:

Measurement ID: The Measurement ID and description is contained in the PRPS or PRD. NOTE: The measurement description is NOT displayed on CRT.

CRT Display: The following CRT display is required "High Rate Meas. X X X X", where X X X X refers to the NASA measurement number of the particular measurement selected. The measurement number portion of the CRT display for channels with no assigned measurements shall be "XXOOMN" where M and N are the numbers from C-START windows 8 and 7.

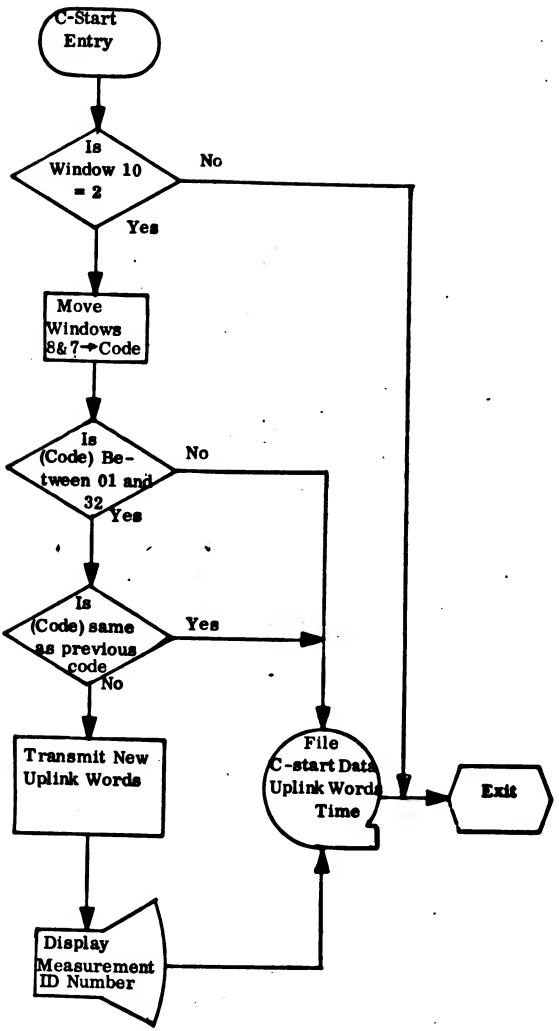
Filing Requirements: None

Remarks:

The high rate measurements are sampled 400 samples per second, spaced symmetrically in the telemetry format, by the analog gates in the PCM carry-on system. The time duration over which the measurement is recorded on the analog recorder is determined by the operator.

The required high rate channel information for any given vehicle will be defined by AC in the Programming Requirements issued in a GAEC or NAA process specification.

Providing an ACE program that will enable switching of all 32 channels will permit further expansion of the list of high rate signals without the need to reprogram the ACE computer. Suitable limit checks on the number of measurements available, perhaps supplied as a card input to the ACE program, would prohibit calling up an unused channel.



Flow Diagram

Figure 641-1

Title: Special IMU Processing G&N 652

Part Of: Communication Program

Purpose: This program converts the IMU 1X gimbal resolver sin and cos PCM values to degrees for display on the CRT. This subprogram specification is identical to the specification for G&N 152 (See 4-152.1.)

Title: ACE-S/C Error Reset Program G&N 671

Part Of: Downlink Program

Purpose: This subprogram resets the error displays on the CRT display unit to give a "no error" indication for the ACE-S/C subprograms utilized with the LEM Block II G&N System.

Calling Sequence: Entry: This subprogram operates under executive control and is initiated from the R-START Module specified in the PRPS or PRD.

Exit: Return to Downlink Executive Program after error displays are reset.

Computation Sequence: The error displays reset by this subprogram are listed below, along with the ACE-S/C subprogram that generates them during its operation. The CRT page and line location for each error display is detailed in the Program Requirements Process Specification.

Error Indication	G&N Program Number
TIME ERROR (1)	601
TIME ERROR (2, 4)	602
TIME ERROR (3)	603
SYNCERR (1, 2)	621 or 221
WORDERR (1, 2, 3, 4, 5, 6)	
RELERR (1)	622
PARERR (1)	631
KEYERR (1)	
VERROR (1, 2, 3, 4, 5)	632
FSERR (1)	681

Each error display consists of a variable segment (underlined) which signifies the type of error condition occuring in a particular ACE-S/C subprogram, and a fixed title segment. When initiated by the operator, this subprogram will blank out the variable segments of the error displays.

Operator Action:

Console Operator: Operator action is required to initiate this subprogram via the R-START module.

Spacecraft Operator: No activity required.

Uplink Requirements:

The ACE-S/C Uplink system is not utilized.

Downlink Requirements:

PCM data processing is not required by this subprogram.

Title: PIPA Switching and Stabilization Loop Response Test G&N 681

Part Of: Uplink Program

Purpose: This subprogram provides step inputs to the IRIG stabilization loop, for the servo loop response test and enables display of the PIPA signal generator outputs. This subprogram specification is identical to the specification for G&N 181. (See 4-181.1).

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CM AND LM G & N TESTING

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12/8/66	A	32263	2, 3, 81, 115, 199, 200, 206, 209, 214-345.	EA	WLS
			Was 345 pages, Now 352 pages. RDL/mc		
12/21/66	B	32361	266, 270 RDL/mc	JP	--

This specification consists of 352 total pages, inclusive.

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			Was 345 pages, Now 352 pages. ROC/MC		
12/21/66	B	32361	266, 270 ROC/MC	JP	--

This specification consists of 352 total pages, inclusive.

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Table 224A-1
Nominal GC Downlink List

Word NO.	Word Name	G&N 224A-1 Processing Requirements
1	01724	None
2	00437	None
3	PIPAX	Defined in Table 224A-2
4	PIPAY	Defined in Table 224A-2
5	PIPAZ	Defined in Table 224A-2
6	BMAGY	Defined in Table 224A-2
7	BMAGX	Defined in Table 224A-2
8	BMAGZ	Defined in Table 224A-2
9	PUSHLOC	None
10	PRIORITY	None
11	LOC	None
12	BANKSET	None
13	DELVX	None
14	DELVX+1	None
15	DELVX+2	None
16	DELVX+3	None
17	DELVX+4	None
18	DELVX+5	None
19	SELFRET	None
20	SMODE	None
21	SFAIL	None
22	ERCOUNT	None
23	IMODES30	Defined in Table 224A-2
24	IMODES33	None
25	DESOPTT	None
26	DESOPTS	None
27	CDUX	Defined in Table 224A-2
28	CDUY	Defined in Table 224A-2
29	CDUZ	Defined in Table 224A-2

Table 224A-1
Nominal GC Downlink List

Word NO.	Word Name	G&N 224A-1 Processing Requirements
1	01724	None
2	00437	None
3	PIPAX	Defined in Table 224A-2
4	PIPAY	Defined in Table 224A-2
5	PIPAZ	Defined in Table 224A-2
6	BMAGY	Defined in Table 224A-2
7	BMAGX	Defined in Table 224A-2
8	BMAGZ	Defined in Table 224A-2
9	PUSHLOC	None
10	PRIORITY	None
11	LOC	None
12	BANKSET	None
13	DELVX	None
14	DELVX+1	None
15	DELVX+2	None
16	DELVX+3	None
17	DELVX+4	None
18	DELVX+5	None
19	SELFRET	None
20	SMODE	None
21	SFAIL	None
22	ERCOUNT	None
23	IMODES30	Defined in Table 224A-2
24	IMODES33	None
25	DESOPTT	None
26	DESOPTS	None
27	CDUX	Defined in Table 224A-2
28	CDUY	Defined in Table 224A-2
29	CDUZ	Defined in Table 224A-2

TABLE 224A-2

WORD NO.	WORD NAME	BITS	DATA MANIPULATION See Notes (-)	DISPLAY	SCALE FACTOR
3	PIPAX	1-15	CONVERT TO DECIMAL	PIPAX±XXXXX	1
4	PIPAY	1-15	CONVERT TO DECIMAL	PIPAY±XXXXX	1
5	PIPAZ	1-15	CONVERT TO DECIMAL	PIPAZ±XXXXX	1
6	BMAGY	1-15	CONVERT TO DECIMAL	BMAGX±XXXXX	1
7	BMAGX	1-15	CONVERT TO DECIMAL	BMAGY±XXXXX	1
8	BMAGZ	1-15	CONVERT TO DECIMAL	BMAGZ±XXXXX	1
23	IMODES30	1	(a)	IGN PIP FAIL ON (OFF)	N/A
23	IMODES 30	2	NONE	N/A	
23	IMODES30	3	(a)	IGN ICDU FAIL ON (OFF)	N/A
23	IMODES30	4	(a)	IGN IMU FAIL ON (OFF)	N/A
23	IMODES30	5	NONE	N/A	N/A
23	IMODES30	6	(a)	INITIALIZE ISS ON (OFF)	N/A
23	IMODES30	7-15	NONE	N/A	N/A
27	CDUX	1-15	(j)	CDUX XXX. XX DEG	N/A
28	CDUY	1-15	(j)	CDUY XXX. XX DEG	N/A
29	CDUZ	1-15	(j)	CDUZ XXX. XX DEG	N/A
31	CDUS	1-15	(j)	CDUS XX. XXX DEG	N/A
32	CDUS	1-15	CONVERT TO DECIMAL	CDUs XXX. XX DEG	$180°/2^{14}$
37	REDOCTR	1-15	CONVERT TO DECIMAL	REDOCTR XXXXX	$180°/2^{14}$
38	FAILREG	1-15	DISPLAY IN OCTAL	FAILREG XXXXX	N/A
39	OPTMODES	1	NONE	N/A	N/A
39	OPTMODES	2	(a)	IGN OCDU FAIL ON (OFF)	N/A
39	OPTMODES	3	(a)	OPT ZEROING ON (OFF)	N/A
39	OPTMODES	4-5	(c)	OPT SWITCH XXX	N/A
39	OPTMODES	6-15	NONE	N/A	N/A
51	DRIFTO	1-15	CONVERT TO DECIMAL	V DRIFTO±XXX. XX MERU	$1000/2^{14}$
53	DRIFTI	1-15	CONVERT TO DECIMAL	S DRIFTI±XXX. XX MERU	$1000/2^{14}$
55	DRIFTT	1-15	CONVERT TO DECIMAL	E DRIFTT±XXX. XX MERU	$1000/2^{14}$
59	ANGZ	1-15	CONVERT TO DECIMAL	ANGZ±. XXXXX	$1/2^{14}$

TABLE 224A-2

WORD NO.	WORD NAME	BITS	DATA MANIPULATION See Notes (-)	DISPLAY	SCALE FACTOR
3	PIPAX	1-15	CONVERT TO DECIMAL	PIPAX±XXXXX	1
4	PIPAY	1-15	CONVERT TO DECIMAL	PIPAY±XXXXX	1
5	PIPAZ	1-15	CONVERT TO DECIMAL	PIPAZ±XXXXX	1
6	BMAGY	1-15	CONVERT TO DECIMAL	BMAGX±XXXXX	1
7	BMAGX	1-15	CONVERT TO DECIMAL	BMAGY±XXXXX	1
8	BMAGZ	1-15	CONVERT TO DECIMAL	BMAGZ±XXXXX	1
23	IMODES30	1	(a)	IGN PIP FAIL ON (OFF)	N/A
23	IMODES 30	2	NONE	N/A	N/A
23	IMODES30	3	(a)	IGN ICDU FAIL ON (OFF)	N/A
23	IMODES30	4	(a)	IGN IMU FAIL ON (OFF)	N/A
23	IMODES30	5	NONE	N/A	N/A
23	IMODES30	6	(a)	INITIALIZE ISS ON (OFF)	N/A
23	IMODES30	7-15	NONE	N/A	N/A
27	CDUX	1-15	(j)	CDUX XXX. XX DEG	N/A
28	CDUY	1-15	(j)	CDUY XXX. XX DEG	N/A
29	CDUZ	1-15	(j)	CDUZ XXX. XX DEG	N/A
31	CDUS	1-15	(i)	CDUS XX. XXX DEG	N/A
32	CDUS	1-15	CONVERT TO DECIMAL	CDUS XXX. XX DEG	$180°/2^{14}$
37	REDOCTR	1-15	CONVERT TO DECIMAL	REDOCTR XXXXX	$180°/2^{14}$
38	FAILREG	1-15	DISPLAY IN OCTAL	FAILREG XXXXX	N/A
39	OPTMODES	1	NONE	N/A	N/A
39	OPTMODES	2	(a)	IGN OCDU FAIL ON (OFF)	N/A
39	OPTMODES	3	(a)	OPT ZEROING ON (OFF)	N/A
39	OPTMODES	4-5	(c)	OPT SWITCH XXX	N/A
39	OPTMODES	6-15	NONE	N/A	N/A
51	DRIFTO	1-15	CONVERT TO DECIMAL	V DRIFTO±XXX. XX MERU	$1000/2^{14}$
53	DRIFTI	1-15	CONVERT TO DECIMAL	S DRIFTI±XXX. XX MERU	$1000/2^{14}$
55	DRIFTT	1-15	CONVERT TO DECIMAL	E DRIFTT±XXX. XX MERU	$1000/2^{14}$
59	ANGZ	1-15	CONVERT TO DECIMAL	ANGZ±. XXXXX	$1/2^{14}$

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(M) 12/21/66	B	32361	266, 270 ROC/AC	JP	--
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TABLE 121-3

DOWNLIST 017-1

Position	Block	Position	Block
1	ID (62067)	41	VRECT
2	DSPTAB	42	VRECT +1
3	DSPTAB +1	43	VRECT +2
4	DSPTAB +2	44	VRECT +3
5	DSPTAB +3	45	VRECT +4
6	DSPTAB +4	46	VRECT +5
7	DSPTAB +5	47	TFF
8	DSPTAB +6	48	TFF +1
9	DSPTAB +7	49	TMMARKER
10	DSPTAB +8	50	TMMARKER
11	DSPTAB +9	51	TMMARKER
12	DSPTAB +10	52	DSPTAB
13	DSPTAB +11	53	DSPTAB +1
14	DSPTAB +12	54	DSPTAB +2
15	DSPTAB +13	55	DSPTAB +3
16	TIME 2	56	DSPTAB +4
17	TIME 1	57	DSPTAB +5
18	IN 0	58	DSPTAB +6
19	IN 2	59	DSPTAB +7
20	IN 3	60	DSPTAB +8
21	OUT 1	61	DSPTAB +9
22	STATE	62	DSPTAB +10
23	FLAGWRD1	63	DSPTAB +11
24	FLAGWRD2	64	DSPTAB +12
25	CDUX	65	DSPTAB +13
26	CDUY	66	RN
27	CDUZ	67	RN +1
28	REDOCNTR	68	RN +2
29	DELVX	69	RN +3
30	DELVX +2	70	RN +4
31	DELVX +4	71	RN +5
32	THETAD	72	VN +0
33	THETAD +1	73	VN +1
34	THETAD +2	74	VN +2
35	RRECT	75	VN +3
36	RRECT +1	76	VN +4
37	RRECT +2	77	VN +5
38	RRECT +3	78	PIPTIME
39	RRECT +4	79	PIPTIME +1
40	RRECT +5	80	TIME 2 GR

TABLE 121-3

DOWNLIST 017-1 (Continued)

Position	Block	Position	Block
81	TIME 1 GR	91	VAVEGON +1
82	TCUTOFF	92	VAVEGON +2
83	TCUTOFF +1	93	VAVEGON +3
84	RAVEGON	94	VAVEGON +4
85	RAVEGON +1	95	VAVEGON +5
86	RAVEGON +2	96	TAVEGON
87	RAVEGON +3	97	TAVEGON +1
88	RAVEGON +4	98	TMMARKER
89	RAVEGON +5	99	TMMARKER
90	VAVEGON	100	TMMARKER

TABLE 121-3

DOWNLIST 017-2

Position	Block	Position	Block
1	ID (62001)	24	FLAGWRD 2
2	DSPTAB	25	CDUX
3	DSPTAB +1	26	CDUY
4	DSPTAB +2	27	CDUZ
5	DSPTAB +3	28	-SPARE-
6	DSPTAB +4	29	STCNTR
7	DSPTAB +5	30	STBUFF
8	DSPTAB +6	31	STBUFF +1
9	DSPTAB +7	32	STBUFF +2
10	DSPTAB +8	33	STBUFF +3
11	DSPTAB +9	34	STBUFF +4
12	DSPTAB +10	35	STBUFF +5
13	DSPTAB +11	36	STBUFF +6
14	DSPTAB +12	37	STBUFF +7
15	DSPTAB +13	38	STBUFF +8
16	TIME 2	39	STBUFF +9
17	TIME 1	40	STBUFF +10
18	IN 0	41	STBUFF +11
19	IN 2	42	STBUFF +12
20	IN 3	43	STBUFF +13
21	OUT 1	44	-SPARE-
22	STATE	45	-SPARE-
23	FLAGWRD1	46	-SPARE-

Table 124-012-3

Index No.	Data Word Description	Processing Requirements
30	V_{gy} MSB	None
31	V_{gy} LSB	
32	V_{gz} MSB	
33	V_{gz} LSB	
34	X comp. of sighting vector MSB	
35	X comp. of sighting vector LSB	
36	Y comp. of sighting vector MSB	
37	Y comp. of sighting vector LSB	
38	Z comp. of sighting vector MSB	
39	Z comp. of sighting vector LSB	
40	X comp. of maneuver vector MSB	
41	X comp. of maneuver vector LSB	
42	X comp. of maneuver vector MSB	
43	Y comp. of maneuver vector LSB	
44	Z comp. of maneuver vector MSB	
45	Z comp. of maneuver vector LSB	
46	Desired CDU X	
47	Desired CDU Y	
48	Desired CDU Z	
49	DUMMY MARKER	
50	DUMMY MARKER	
51	DUMMY MARKER	
52	DSPTAB +0	Display Table Data. Processed by G&N 122.
53	DSPTAB +1	
54	DSPTAB +2	
55	DSPTAB +3	
56	DSPTAB +4	
57	DSPTAB +5	
58	DSPTAB +6	

c) Determine which value, SINθ or COSθ, is within the range of its calibration data and interpolate to get an angle θ. If both are within the range use SINθ. If both are out of range, display 'OOR' on the CRT in place of an angle.

d) Compensate for quadrant and display the angle:

Quadrant	Display
1	θ
2	180° $-\theta$
3	180° $+\theta$
4	360° $-\theta$

Operator Action: No activity required.

Uplink Requirements: None

Downlink Requirements:

Measurement ID: The measurements to be processed by this subprogram will be specified in the PRPS or PRD.

CRT Display: 1. XXX accurate to one degree
2. Page, lines and fixed CRT annotation specified in PRPS or PRD.

Tolerance: None

Filing Requirements: None

Remarks: Definition of terms used in Computation Sequence:

Sinθ Incoming PCM value for sin measurement.

Cosθ Incoming PCM value for Cos measurement.

CIS1 Calibration input for sin measurement at point 1 (0°).

CIC1 Calibration input for Cos measurement at point 1 (90°).

Operator Action: Console Operator: Operator action is required to initiate this subprogram via the R-START module.

Spacecraft Operator: No activity required

Uplink Requirements:

The ACE Uplink System is not utilized.

Downlink Requirements:

PCM data stream is not required by this subprogram.

Title: PIPA Switching and Stabilization Loop Response Test G&N 181

Part Of: Uplink Program

Purpose: This program enables a step voltage input into the stabilization loop, for the stabilization servo loop response test, and display of the PIPA signal generator outputs.

Calling Sequence: Entry:

1) This subprogram will operate under executive control and is initiated from an R-START Module specified in the PRPS for the stabilization loop response test.

2) This subprogram is also initiated via a specified R-START Module to allow monitoring of the PIPA signals.

Data: Input to this subprogram is supplied by the CUE upon R-Start execution. This data includes the start module address and the status of the function switches.

Output from this subroutine consists of a series of relay command words.

Normal Exit: Return to Uplink Executive Program.

Error Exit: CRT error display and Uplink Command Tape recording, prior to transfer to the Uplink Executive Program.

Computation Sequence:

Upon R-START execution, this subprogram checks to determine if more than one function switch has been depressed. If so, this program generates an error message for display and recording purposes, blanks out current CRT display and transfers control to the Uplink Executive Program.

The subprogram also checks to see that there was no more than one change in state from the function switches at the previous XEQ. If there has been more than one state this program generates an error message for Uplink Command Filing and transfers control to the Uplink Executive Program without transmitting relay command words Uplink.

A single function switch depression, with only one change of state present, enables the assembly and transmission of relay command words. Refer to the Vehicle Program Requirements Process Specifications for R-START function switch setting and DTCS addresses.

Operator Action: Console Operator: R-START execution is required to initiate this subprogram as given below.

A) Stabilization Loop Step Input

1) The intended status of the relays is selected by depression of the function switches.

2) The step input is applied to the particular IRIG upon depression of the XEQ switch.

3) The removal of the step input is accomplished by again depressing the function switch so that no switches are illuminated, followed by the XEQ switch.

NOTE: When selecting a series of step inputs, item 3) should always be used to insure that the bank of relays are reset, prior to selecting a new step input.

B) PIPA Signal Display

The operator action required for this function is similar to that described for the stabilization loop step input, with the exception of the R-START module location. Only one PIPA signal is displayed at a time and is accomplished by means of the function switch selection as given under Computation Sequence. To remove the PIPA display requires that the operator depress the function switch again and then the XEQ switch.

Spacecraft Operator: No activity required.

Uplink Requirements:

DTCS Transmission: A twenty-four bit command word is compiled in the Uplink computer containing the "carry-on" relay address and the relay status.

DTCS Stimuli: The relay addresses are listed in the Vehicle PRPS.

Transmission Time: During G&N system test, the sequence of subprogram initialization, will be specified in the "Operational Checkout Procedures". All other times, the transmission time will be as required.

Filing Requirements: The complete command history is recorded on the Uplink Command tape.

Downlink Requirements:

CRT Display

1) A display occurs to identify a particular PIPA measurement, appearing on the oscilloscope. The display consists of the following format:

"PIPA MEAS. XXX"

where XXX = REF, X, Y or Z.

The variable portion of the format (underlined) will appear upon operator selection of a PIPA measurement. This display will be blanked when operator action removes this selection by means of the function switches.

2) An error indication is displayed in the following format "FSERR 1". Refer to the "Program Requirements Process Specification" for details on CRT page and line information.

Title: G&N Downlink Edit Program - Block II and LEM

Program Number: G&N No. 210

Purpose: The G&N Downlink Edit Program strips outs, interprets and presents all or any part of the Command Guidance Computer (CGC) and the LEM Guidance Computer (LGC) data recorded on the PCM Data Tape.

Input: The inputs to this program are:

1) PCM Data Tape or Compressed Data Tape containing CGC/LGC data.
2) Edit Parameters (cards or tape)
3) Control cards

Output: The output from this program is a printed listing of CGC/LGC Downlink data taken from the PCM Data tape or CDT for the intervals requested and processed and displayed in the manner defined by the Edit Parameters.

General Program Description: The G&N Downlink Edit-Block II is divided into two segments to minimize the impact of changes in the input data format. The two segments are:

1) EXECUTIVE SEGMENT - This segment prepares the Edit Parameters for use, processes the Control Cards, extracts the CGC/LGC data from the PCM Data tape or CDT for the intervals defined, validates this data and transmits it to the next segment.

2) PRESENTATION SEGMENT - This segment receives the CGC/LGC data and the Edit Parameters from the Executive Segment and processes and prints out this data in the manner prescribed by the Edit Parameters.

Printing: Printing will be once every complete cycle through the Downlink list. The Downlink Edit Format Tables will define either an entire page to be printed (over 6 lines per ID) or a subpage (6 lines or less) to be printed under line count control.

Execution: In most cases, it will not be necessary to see all the data on the PCM Data Tape or CDT. The intervals to be processed will be specified in the Zulu Time as it appears on the PCM Data Tape or CDT and will be input to the program on control cards.

Data Rate: CGC/LGC Data is recorded on analog PCM Data Tapes at bit rates of:
1) 204.8KBS
2) 51.2KBS
3) 1.6KBS
This program must be able to process data at any and all of these rates.

Title: EXECUTIVE SEGMENT

Purpose: The purpose of the Executive Segment is to prepare the Edit Parameters for use by the Presentation Segment, processes the Control Cards, and to extract and validate the required CGC/LGC data from the PCM Data Tape.

Input: The inputs to this segment are:

1) Downlink Edit Format and Requirements Tables (Edit Parameters)
2) Data Definition, Title and Time Cards (Control Cards)
3) PCM Data Tape or CDT containing the CGC/LGC data to be processed.

Output: The outputs from this segment are:

1) Edit Parameters for use by the Presentation Segment
2) CGC/LGC data extracted from the PCM Data Tape or CDT
3) Error signals for any discrepancies found in the Edit Parameters, the Control Cards, and the CGC/LGC data.

Normal Exit: The normal exit from this segment is to the Presentation Segment. The normal program halt occurs when the last time interval has been satisfied.

Error Exit: Error signals are generated for discrepancies found in the Input Cards, PCM or CDT Data. The Error Exit is to the Presentation Segment.

Description: The CGC/LGC data consists of two types of words:

1) Identification Words (2): These words indicate the type of downlink transmission (List) and signal the start of the data transmission.
2) Data Words (98): Actual CGC/LGC words. The position of a data word in a List identifies its content. There is a unique Word Order Code associated with each type of word.

The first card to be input is the Data Definition Card. This card identifies the position of the CGC/LGC words in a Prime Frame of PCM Telemetry Data.

The List being sent changes during the various phases of a mission program. A set of Edit Parameters is required for each List. The number of Lists to be used during the missions utilizing Block II Computers is not known; as a preliminary estimate, this program should be able to accomodate up to twenty different lists.

A set of Edit Parameters for any List will consist of:
1) LIST ID card - This card contains the bit configuration (in octal) of the ID Words of the List for which the tables following this card are to be used.

2) R cards - These cards define the print format of the data for the particular list.

3) ENG card - These cards define the English phrase interpretations for the particular List.

4) E Cards - These cards define the processing requirements for the particular list.

5) END Card - This card is the last card of the set of Edit Parameters for the particular List.

This sequence of cards will be repeated for each List.

Run cards to be input with each run will consist of:

1) G&N card - This card will contain the description of the particular run and will be used as a page heading on the output listing.

2) TIME cards - These cards will designate the data to be processed. Each card will contain a start and a stop time in hours, minutes, and seconds. If more than one TIME card is used, the times specified will not overlap and will be in sequence.

3) END OF RUN card - signals the end of the Control Cards.

Appropriate validity checks should be made on the format of these cards. Any card error will suspend the processing of and PCM or CDT Data, but all cards should be scanned and all errors displayed even though no data will be processed.

Usage of the Downlink Edit Program - Block I has shown that the Edit Parameters tend to be fixed once the data content of the Downlink is known. New sets of Edit Parameters will be used only for special applications. The Executive Segment should process the Downlink Edit Format Tables and the Downlink Requirements Tables and save them on tape so that subsequent runs with the same type of data may be made with no reprocessing of those cards.

Time: There is a time signal on the PCM Data Tape and the CDT and the time of transmission of each CGC/LGC word can be determined. This time is matched to the time intervals requested to determine what data is to be processed. Data should be processed from the first ID following the start time to the end of the Downlist after the stop time. The time occurance of the ID Word must be available to the Executive Segment.

Data Form: The CGC/LGC transmitts blocks of five 8 bit words into the PCM stream of telemetry. These forty bits contain the data to be processed. Fifty of these blocks represent a complete cycle through a Downlink List. The Downlist consists of a fixed length of 100 CGC/LGC words, each block representing 2 of these words. The first block of a Downlist contains the ID Words. These words identify the List being transmitted. Following the ID Words are 98 Data words CGC/LGC words are 16 bits in length and are configured as:

8/15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 P

where: bit 15 is the Sign bit for numeric data bits 14 thru 1 are the data bits for numeric data P is the Parity (Odd) bit.

Validation: The Validity checks to be made on the CGC/LGC data are:

1) Check - Out of Sync signaled by DECOM
Action - Message SYNCERR1, indicate which words are out of sync but process anyway.

2) Check - Over ninety-eight data words since ID words
Action - Message SYNCERR2, process first ninety-eight data words and ignore the rest until ID words received.

3) Check - ID Words received before ninety-eight data words were received since last ID Words.
Action - Message SYNCERR3, process data wards received begin next Downlist with new ID Words.

4) Check - Parity incorrect in first CGC/LGC word in block
Action - Message WORDERR1, display the 40 bits in Octal and the index number. Do not process the word in error.

5) Check - Parity incorrect in second CGC/LGC word in block
Action - Message WORDERR2, display the 40 bits in Octal and the index number. Do not process the word in error.

6) Check - First ID Word, bits 15 to 11 Invalid
Action - Message WORDERR3

7) Check - First ID Word, bits 10 to 1 Invalid
Action - Message WORDERR4, Invalid ID, display the 40 bits in octal and the index number. Cycle until next ID received.

8) Check - Second ID Word Invalid
Action - Message WORDERR5, display 40 bits in octal. If no error was found in the first ID Word, the ID will be considered Valid and ID word 1 will be used to determine the list being sent.

NOTE: WORDERR3 alone will not invalidate the ID. If no other ID errors are found, bits 10 to 1 of ID word 1 will determine the list being sent.

TITLE: PRESENTATION SEGMENT

Purpose: The Presentation Segment receives the 16 bit COC/LOC words from the Executive Segment. These words are processed in the manner defined by the Downlink Requirements Tables and displayed in the manner defined by the Downlink Edit Format Tables.

Input: The inputs to this segment are:
1) Edit Parameters and ID Word configurations for all Dowalists to be processed.
2) The 16 bit COC/LOC Words.
3) Error indicators associated with the 16 bit words transmitted.

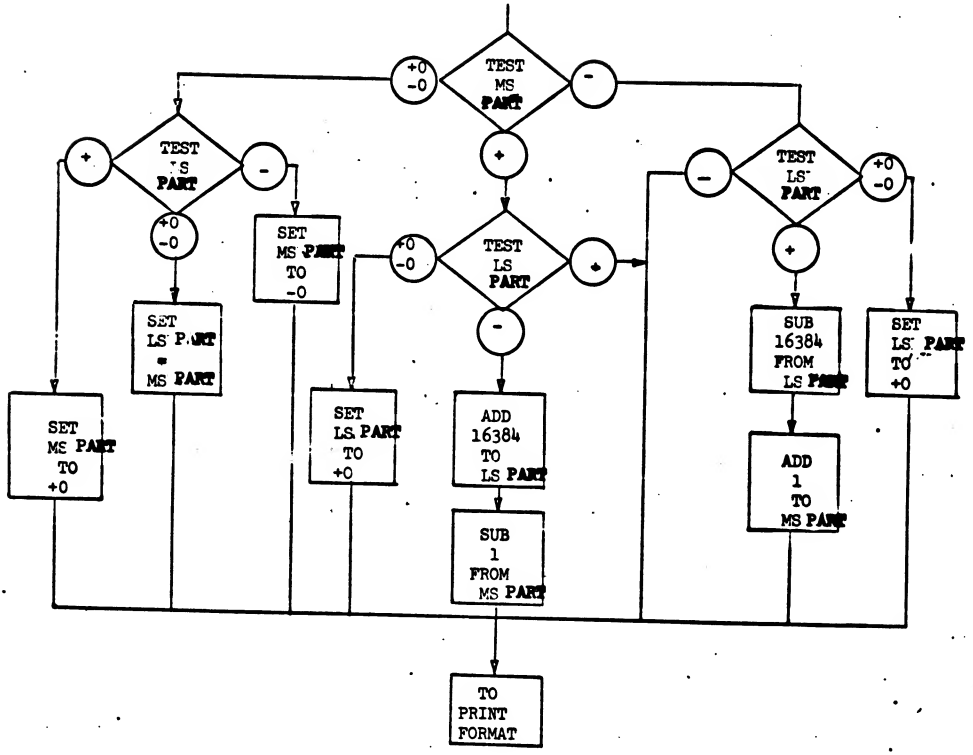
Output: The output from this segment is the printed listing in the formats defined by the Edit Parameters and any error messages generated.

Exits: The normal and the error exits from this segment are to the Executive Segment.

Description: This segment receives the 16 bit COC/LOC words and any error signals from the Executive Segment. Each word is examined to determine if it is on ID Word or a Data Word. When the ID Words are received, the time of their occurance is printed as positioned by an E card. The Edit Parameters for data following the particular ID are made ready for processing. The ID words may be processed as data words for printing. When Data Words are received, a check of the Edit Parameters will determine if the word is to be used, and if so, how to process it. Error signals generate output messages. All COC/LOC words are treated as binary fractions with the binary point between the 15th and 14th bits of the word. Double Precision quantities will require that processing be held up until both words have been received.

Note that the most significant part and the least significant part of a double precision word do not necessarily have the same sign. Use the following diagram for a processing technique.

Method For Handling Double Precision Words:



Card Formats:

Data Definition Card - This card locates the two sixteen bit CGC/LGC words and the Word Order Code (WOC) contained in the 40 bits defined. This card also will define the representative WOC bit for ID Words. That is, the bit (0 or 1) indicated will be in each bit position of the WOC for ID Words. The 5-8 bit words will be considered as individual bits numbered 1 to 40 with the left most bit of the first word called bit 1 and numbered consecutively to the right most bit of the fifth word, bit 40.

Columns	Contents	Comments
1 to 4	DATA	defines card type
9 to 11	PCM	comment
22 to 25	WRD1	comment
27 to 31	XX-XX	first and last bit position of CGC/LGC word 1
34 to 37	WRD2	comment
39 to 43	XX-XX	first and last bit position of CGC/LGC word 2
46 to 48	WOC	comment
50 to 54	XX-XX	first and last bit position of word order code
57 to 61	IDWOC	comment
63	X	WOC representative bit for ID Words

Comments need not be checked for. The CGC/LGC words should be 16 bits in length, the word order code may be from 1 to 8 bits. All WOC bits will be identical if more than one is specified. The representative WOC bit for ID words is supplied. Data word WOC is assumed to be the complement of the ID WOC. See card example page for further clarification.

Downlink Edit Format Tables: A Downlink Edit Format Table is required for each Downlist to be processed. This table specifies the fixed format layout of the edit listing. A field width of 120 print characters is required. The spacing alloted between the title entries of this table is for the insertion of the CGC/LGC data as processed by the Presentation Segment. This table is composed of R cards. These cards provide the titled entries for the edit listing. No more than two cards are used to define any single line of the listing. The set of R cards for any Downlist will not define over 50 lines including spacing.

Columns	Contents	Comments
1	R	defines card type
6, 7	XX	line sequence number
8	y	print control
9 to 80		fixed format layout

where: XX R cards for a particular List are in sequence by this number. This number is used by the E cards to identify the lines on which the processed data will be displayed.

y = blank or 1, skip one line after printing
= 2, skip two lines after printing
= 9, fixed format layout of this card is the right most poriton of the previously defined line

If y is blank, 1, or 2, columns 9 thru 80 of the card will be printed in print positions 1 to 72.
If y is 9, columns 9 thru 56 will be printed in print positions 73 to 120.

Downlink Requirements Tables:

A Downlink Requirements Table is needed for each Downlist to be processed. This table defines the specific entries required for the edit listing by referencing the index number (word position in Downlist) of the words to be processed. This table specifies the exact placement, in terms of print positions, of each data entry in the fixed edit format defined by the Downlink Edit Format Table for this Downlist. This table also specified the processing required for each data entry in the output. A Downlink Requirements Table is composed of E cards and ENG cards.

Columns	Contents	Comments
1	E	defines card type
9, 10	XX	line number (match to R card line sequence number)
12 to 18	XXX-XXX	print positions in output line where this entry is to be displayed.
25 to 30	EQUALS	
32 to 34	XXX	index number (001 to 100)
	For quantitites to be displayed in decimal	
36 to 62	DP or SP (Double or Single Precision), Scale Factor (sign, decimal point, one to ten decimal digits), power (E, sign, one or two decimal digits), S or NS (if S, print sign; if NS treat word as 15 bit unsigned number), MSB (for double precision, indicates most significant bits)	
	For other quantitites	
36 to 50	XX or XX-XX or XX,XX-XX (bit positions to be considered - leading zeros not supplied) OCTAL (print bits indicated in octal) or BINARY (print bits indicated in binary) or ENGn (Extract bits indicated and search English table specified for match and insert associated phrase in output), I or blank (I, if bit 15 of the word is a 1, the bits indicated must be complimented before processing; if field is blank or if bit 15 is 0, the bits indicated are used as is).	

Fields will be seperated by commas, and except where mentioned, lead zeros will be supplied.

The ENGn cards contain English phrases to inserted in the output listing when certain combination of bits are present in key CGC/LGC words. The bits for comparison and the table to be searched are indicated by E cards.

Columns	Contents	Comments
1 to 3	ENG	defines card type
4	n	table number (n = 1 to 8)
8 to 23	1 to 16 binary characters that is the bit pattern for which the English phrase will be substituted (bits specified n in E card are extracted and compared to the non-blank columns - right justified to column 23)	
25 to 30	EQUALS	
33 to 53	1 to 20 alphanumeric characters to be inserted in print positions defined in the E card - left justified to column 33. A $ in column 33 means that no phrase is to be inserted for the bit pattern matched.	

Downlink Requirements Tables:

If the designated ENGn table is searched and no match is found, an error condition exists. A message, DOWNERR1 is printed along with the index number of the word that contained the bits that could not be matched and the word (16 bits) in octal.

NOTE:

A special application of the E card will be used to position the time of the ID word in the edit listing. Index word 000 will indicate this time and it will be positioned in the normal manner. E.G.

E 06,018-037 EQUALS 000

Print GMT on the line defined by R 06 in print positions 018 through 037. The processing requirements for this word are already defined.

List Identification Card - This card is the first card of the set of Edit Parameters for a particular Downlist. The bit configurations of the ID Words, whose data will be processed according to the tables following this card, are contained in this card.

Columns	Contents	Comments
1 to 4	LIST	defines card type
7 to 12	XXXXXX	bit configuration in Octal of first ID word
15 to 20	XXXXXX	bit configuration in Octal of second ID word

The 16 binary bits are converted into 6 octal characters by adding two binary zeros to the right to make 18 binary bits E.G. (1100100001101111) will be in the card as 620674.

End Card - This card is the last card of the set of Edit Parameters for a particular Downlist.

Columns	Contents	Comments
1 to 3	END	defines card type

The Edit Parameters for each Downlist consist of: LIST ID card, R cards, ENGn cards, E cards and the END card in that order.

Cards Input for each run: The page title card contains the run description, date, OCP, etc, and is printed once per page.

Columns	Contents	Comments
1 to 3	G&N	defines card type
5 to 75	page title	to be printed as the first line of each page.

The data to be processed are defined as a set of 1 to n time intervals. Each card contains the start and stop time of a data interval. For multiple intervals, the times will not overlap and will be in sequence.

Columns	Contents	Comments
1 to 4	TIME	defines card type
6, 7	XX	start time, hours
8, 9	YY	start time, minutes
10, 11	ZZ	start time, seconds
13, 14	TO	
16, 17	XX	stop time, hours
18, 19	YY	stop time, minutes
20, 21	ZZ	stop time, seconds

The last card to be input is the End of Run card.

Columns	Contents	Comments
1 to 10	END OF RUN	defines card type

Example 1 E 02, 018-026 EQUALS 062,DP,+.16777528E+5,S,MSB

E - specifies requirements equals card
02 - specifies the number of a R card entry in the Edit Format table which designates the line that this data is to be printed on.
018-026 - specifies the print positions of line 02 that this data is to be printed in
062 - specifies the position in the Downlink List (index number) that contains the data to be processed.
DP - specifies that the data is double precision
+.16777528 - specifies the numeric value of the scale factor
E+5 - specifies the power of the scale factor
S - specifies the data is a signed number
MSB - specifies that word 062 is the most signifient bits of the double precision quantity.

This card requires that the 14 data bits of word 062 and the 14 data bits of word 063 be combined as previously described into a 28 bit binary fraction, converted to a decimal fraction, multiplied by 16777.528 and printed in positions 018 to 026 of line 02.

Example 2 E 61,047-062 EQUALS 029,7,5-1,ENG2

E - specifies requirements Equals card
61 - specifies the number of the R card entry
047-062 - specifies the print positions of R 61 for display
29 - specifies the eindex number of the data
7,5-1 - specifies the bits to be extracted from word 029
ENG2 - specifies the table of English phrases that is to be searched for the same pattern of the bits extracted.

This card requires that bits 7 and 5 thru 1 be extracted from word 029. These bits are then compared to the patterns that are part of English phrase table ENG2. When the bits are matched, the English phrase associated with that pattern is printed in print positions 047 to 062 of the line defined by R card 61.

Example 3 E 04, 109-109 EQUALS 012,6,BINARY

E - specifies requirements Equals card
04 - specifies the number of a R card entry
109-109 - specifies the print position on line defined by R04
012 -specifies the index number of the data
6 - specifies the bit position to be extracted from word 12
BINARY - specifies that the bit be displayed in binary.

Example 4 E 06,097-112 EQUALS 026,15-1,OCTAL

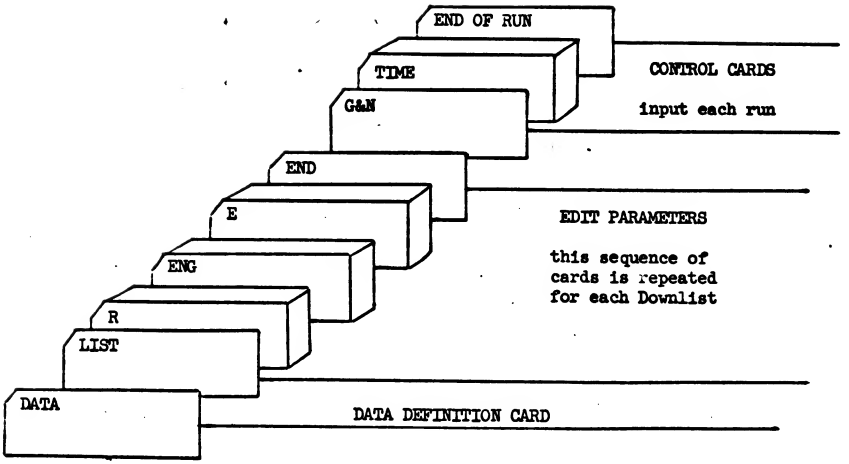
E - specifies requirements Equals card
06 - specifies the R card line number
097-112 - specifies the print position in the line defined by R 06
026 - specifies the index number of the CGC/LGC data
15-1 - specifies the bits of word 012 to be processed
OCTAL - specifies that the data is to be printed in octal

Example 5 ENG2 001001 EQUALS FINE ALIGN

ENG2 - specifies requirements English card
001001 - specifies the bit pattern that will be interpreted by the english phrase
FINE ALIGN - specifies the message that is to be printed in the print positions called out by the E card that refers to the ENG2 table.

This card is actually a sub-card to an E card. The E card specifies the bits of a CGC/LGC word to be compared to the various entries of the ENG2 table and the print positions for the message.

Input Card Deck Makeup:



Input Card Examples:

```
DATA  PCM   MRUPT 021-177 MRD2 1.9  33 MSC 011-011  IDMSC 11
LTST  01625400043174
R     02AGC  TIME  HRS  IMU MODE                    AGC ID
ENG2                  00110001 EQUALS ZERO ENCODER
E     02,0118-0026 EQUALS 016,DP,+.7456,5404,2E+3,S,MSB
E     45,0114-0120 EQUALS 025,SP,+.18UE+3
E     53,0138-0554 EQUALS 020,17,5-1,ENG2,I
E     05,0140-0140 EQUALS 013,11,BINARY
E     05,0149-0223 EQUALS 013,15-1,OCTAL
END
G+N   COMPRESSED TIME MISSION SIMULATION AS-202 OCP-K00335 6/6/66
TIME  14551167 TAG 153220
ENE   RUN
```

References: 1) AC Electronics Diagnostic Program Specification for CMC Block I (CMCD1) - G&N Downlink Edit, Block I

2) [illegible] - ACE S/C Subprogram Specification for the Downlink Format Program, LGC Block II (G&N 621)

3) [illegible] - ACE-S/C Subprogram Specification for the ACE G&N Downlink Edit Program (G&N 010)

Title: GC Downlink Format Program, Block II G&N 221A

Part Of: Downlink Program

Purpose: The GC transmits blocks of five 8-bit words into the PCM T/M at a 50 block per second rate. These data blocks represent a complete cycle through one GC Downlist. The Downlist consists of a fixed length of 100 GC words, each data block representing 2 of these words. The list address contained in the ID word identifies the transmitted parameters.

The Downlink Format subprogram accepts each block of five 8-bit words, verifies parity, and reformats each word into a 16-bit format. The type of GC word represented is identified and the word is routed to other ACE-S/C subprograms for subsequent processing.

Calling Sequence: Entry: This subprogram operates under Downlink Executive Program control and is initiated by receipt of an Executive program interrupt.

Data: 1) A sequence of 50 blocks of five 8-bit words during 1 second.

2) Notification upon loss of a block (prime frame) or sequence of 50 blocks (sub-frame).

Normal Exit: Valid data is transmitted to the appropriate ACE-S/C subprogram for further processing and display.

Error Exit: Error conditions will be displayed on the CRT and filed. A search for an ID word to enable further data processing, occurs under certain error conditions. The CRT error displays are detailed in Table 221A-1.

Computation Sequence:

The program receives blocks of five 8-bit words, configured as follows:

WORD 1	WOC	S/15	14	13	12	11	10	9
WORD 2	8	7	6	5	4	3	2	1
WORD 3	P	S/15	14	13	12	11	10	9
WORD 4	8	7	6	5	4	3	2	1
WORD 5	P	X	X	X	X	X	X	X

where WOC = Word order code (1 bit)
P = Odd parity (GC word)
X = 0 as presently configured

The data block contains 2 GC 16-bit data or DSPTAB words, except where an ID word is encountered. The individual word formats are specified below. The GC data word includes a parity (P) and sign (S) bit. (See Figure 221A.1)

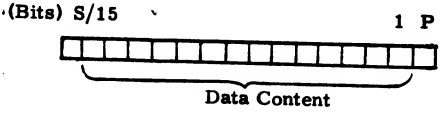
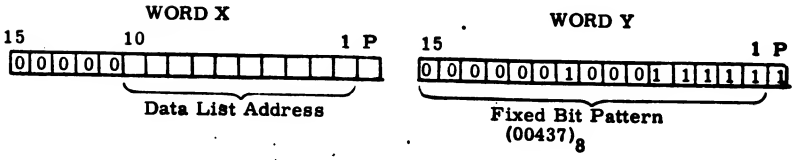


Figure 221A.1

The DSPTAB word format is essentially as specified in Figure 221A.1, as far as this program is concerned.

The identification (ID) word format contains five leading zeros with bits 1-10 containing the data list address. The complete ID word format is:



Word X precedes Word Y in the data block transmittal (Word 1 - Word 5). The Word order code (WOC) bit contains a 1 for all data and DSPTAB words, and a 0 for the ID word. The position of the LGC word in the fixed length list determines whether the word is to be processed for data monitoring or for DSKY display monitoring. The specified Downlink lists which initiate the operation of this program are contained in G&N 224A,Table 224A.1.

Basically, Program G&N 221A receives PCM data blocks, checks parity, and determines the word type, to allow the transfer of 16-bit words to ACE-S/C programs for subsequent processing. A word count is utilized to detect any deviation from the normal list transmission. A block count is also utilized to indicate if both words in the data block have been processed and so allow the reading in of another block.

When an error is sensed, display and recording of pertinent information takes place and depending upon the type of error, control is transferred to point C in the flow chart (Figure 221A-2 where a search for an ID word is initiated.

If a DSPTAB word is detected, then bit 15 is checked for a '1' indication. If a '1' is encountered the word must be complemented prior to transmitting the word to G&N 622A for further processing. Upon detection of an ID word, the data list address is transmitted to G&N 224A to allow that program to utilize the correct display format and scaling information. Figure 221A-2 is given as a representative flow, to convey the intent of the subprogram operation.

Operator Action:	Console Operator: No activity required.
Spacecraft Operator:	No activity required.
Uplink Requirements:	Not applicable.
Downlink Requirements:	Display: This information is detailed in the flow chart and consists of program error displays as specified in Table 221A-1. The ACE requirements specification contains the CRT page and line information.
Filing Requirements:	Upon detection of an error the following information shall be recorded: Time, error name, error number, Data block containing the error and word count.
References:	ACE-S/C Computer Subprogram, G&N 224A Downlink Interpretation Program.

TABLE 221A-1

Error Description	CRT Display
This indicates that Wordcnt has incremented beyond a specified limit.	SYNCERR 1
At this point Wordcnt should be 101, if an ID has been received in the correct sequence.	SYNCERR 2
Parity is incorrect in the first LGC word in data block.	WORDERR 1
Parity is incorrect in the second LGC word in data block.	WORDERR 2
ID word (bits 11 - 15) $\neq (00)_8$	WORDERR 3
Fixed bit pattern in ID word is illegal.	WORDERR 4
Invalid list address encountered after attempting to utilize second LGC word to identify ID word.	WORDERR 5
Invalid list address encountered in the first LGC word in data block.	WORDERR 6

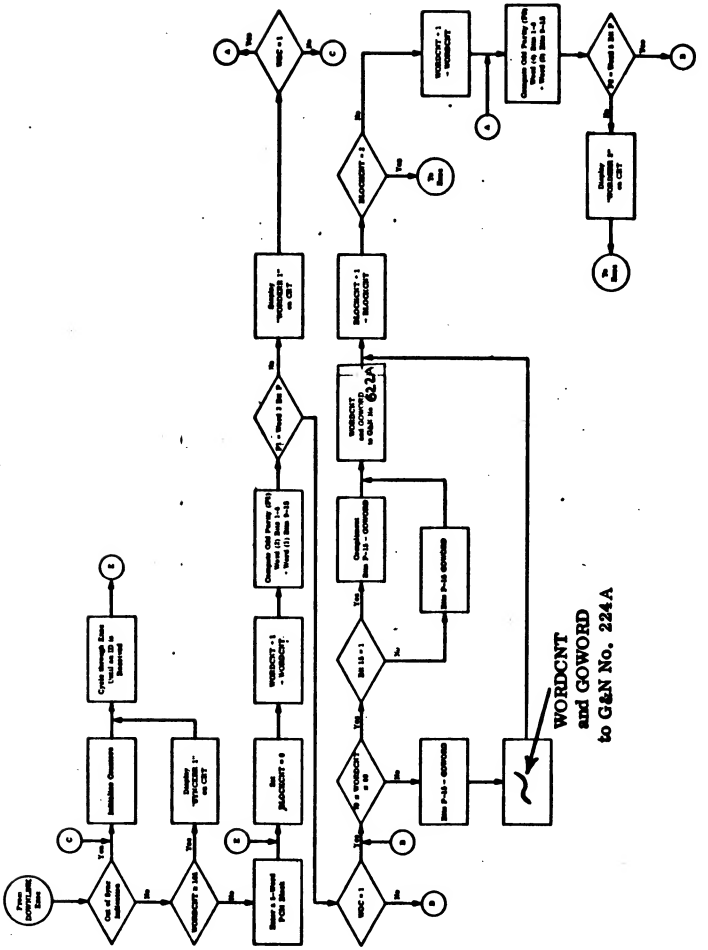


Figure 221A-2 (1 of 2)

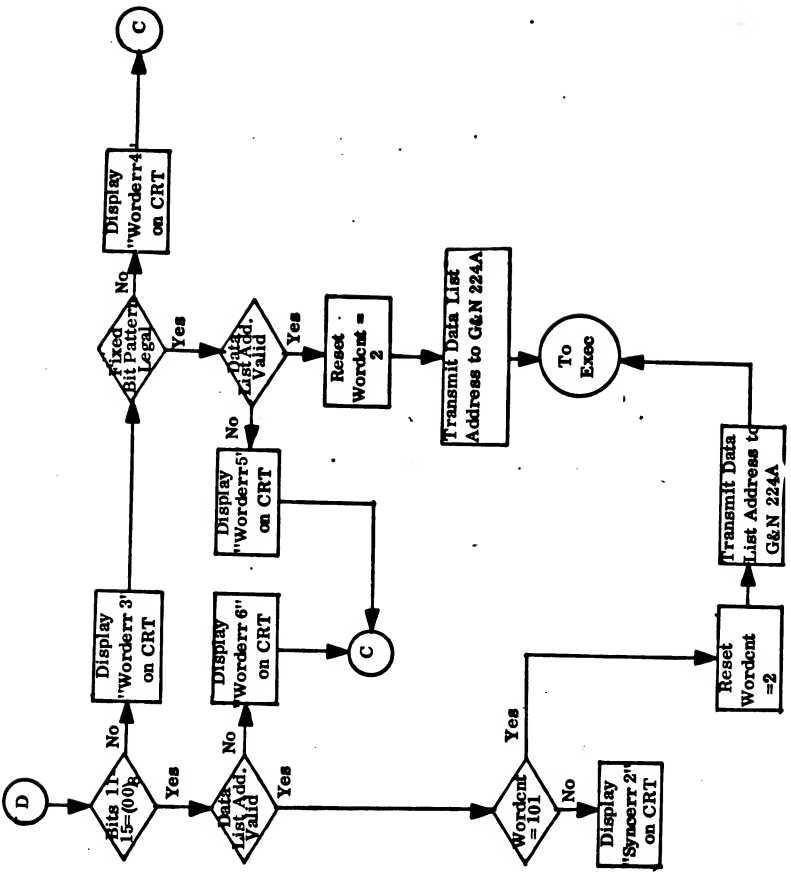


Figure 221A-2 (2 of 2)

Title: GC Downlink Interpretation Program, Block II G&N 224A

Part Of: Downlink Program

Purpose: This subprogram defines the interpretation of the GC Downlink data which is required for ACE-S/C console operator usage and information. The processing requirements for the Nominal GC Downlink list for SUNDIAL is included in this document.

Calling Sequence: Entry: This subprogram is activated by the GC Downlink Format Program, G&N 221A whenever the Format Program is processing Downlink data.

Data Input: Input from G&N 221A to the Downlink Interpretation Program consists of a 16-bit GC data word stored in the computer. Two types of GC words will be processed by G&N 224A:

1) Identification: This word specifies the data list which is being received by G&N 221A.

2) Data: Actual GC data words. The position in the list identifies the data being processed.

Data Output: Output will consist of CRT displays and processed parameters stored in temporary buffers for use by other ACE-S/C G&N. Subprograms and data to be filed if required.

Normal Exit: Return to ACE Executive Program which will supply more data to G&N 221A.

Error Exit: None

Computation Sequence: The Nominal Downlink List for the GC is transmitted once per second and consists of 100 words (two per prime frame).

Table 224A-1 describes the contents of the List and provides the processing requirements for each word.

Operator Action: Console Operator - No activity required.

Spacecraft Operator - No activity required.

Uplink Requirements:

No stimuli required.

Downlink Requirements:

Data Manipulation - Found in the computation sequence section.

CRT Display - The ACE Requirements Specification contains the CRT scope page and line information.

Filing Requirements: Execution of the "RECORD" R-START module function switch specified in the PRPS will cause the filing of a time tag and the following:

Octal words: ID, FAILREG, THETA D, THETA D+1, THETA D+2 STATE, STATE +1, STATE +2, STATE +3

Single Precision Words: CDUX, CDUY, CDUZ, CDUT, CDUS, REDOCTR

Double Precision Words: (TIME 1, TIME 2)

Event Words: IMODES 30, OPTMODES, DSTAB +11, CHNL 11, CHNL 12, CHNL 13, CHNL 30, CHNL 31, CHNL 32, CHNL 33.

Table 224A-1
Nominal GC Downlink List

Word NO.	Word Name	G&N 224A-1 Processing Requirements
1	01724	None
2	00437	None
3	PIPAX	Defined in Table 224A-2
4	PIPAY	Defined in Table 224A-2
5	PIPAZ	Defined in Table 224A-2
6	BMAGY	Defined in Table 224A-2
7	BMAGX	Defined in Table 224A-2
8	BMAGZ	Defined in Table 224A-2
9	PUSHLOC	None
10	PRIORITY	None
11	LOC	None
12	BANKSET	None
13	DELVX	None
14	DELVX+1	None
15	DELVX+2	None
16	DELVX+3	None
17	DELVX+4	None
18	DELVX+5	None
19	SELFRET	None
20	SMODE	None
21	SFAIL	None
22	ERCOUNT	None
23	IMODES30	Defined in Table 224A-2
24	IMODES33	None
25	DESOPTT	None
26	DESOPTS	None
27	CDUX	Defined in Table 224A-2
28	CDUY	Defined in Table 224A-2
29	CDUZ	Defined in Table 224A-2

Table 224A-1 (Continued)

Word No.	Word Name	G&N 224A Processing Requirements
30	CDUT	None
31	CDUT	Defined in Table 224A-2
32	CDUS	Defined in Table 224A-2
33	STATE	None
34	STATE+1	None
35	STATE+2	None
36	STATE+3	None
37	REDOCTR	Defined in Table 224A-2
38	FAILREG	Defined in Table 224A-2
39	OPTMODES	Defined in Table 224A-2
40	SWSAMPLE	None
41	DESOPMOD	None
42	WTOPTION	None
43	IMUCADR	None
44	OPTLADR	None
45	THETAD	None
46	THETAD+1	None
47	THETAD+2	None
48	DESOPTT	None
49	MARKSTAT	None
50	TIMESAV	None
51	DRIFTO	Defined in Table 224A-2
52	DRIFTO+1	None
53	DRIFTI	Defined in Table 224A-2
54	DRIFTI+1	None
55	DRIFTT	Defined in Table 224A-2
56	DRIFTT+1	None
57	GAZIMUTH	None
58	GAZIMUTH+1	None
59	ANGZ	Defined in Table 224A-2
60	ANGZ+1	None

Table 224A-1 (Continued)

Word No.	Word Name	G&N 224A Processing Requirements
61	ANGY	Defined in Table 224A-2
62	ANGY+1	None
63	ANGX	Defined in Table 224A-2
64	ANGX+1	None
65	VLAUN	None
66	VLAUN+1	None
67	WPLATO	None
68	WPLATO+1	None
69	WPLATI	None
70	WPLATI+1	None
71	WPLATT	None
72	WPLATT+1	None
73	PIPAN	Defined in Table 224A-2
74	INTVEC+1	None
75	PIPAE	Defined in Table 224A-2
76	INTVEC+3	None
77	UPLOCK	Defined in Table 224A-2
78	TGLOC	None
79	DSPTAB+0	None
80	DSPTAB+1	None
81	DSPTAB+2	None
82	DSPTAB+3	None
83	DSPTAB+4	None
84	DSPTAB+5	None
85	DSPTAB+6	None
86	DSPTAB+7	None
87	DSPTAB+8	None
88	DSPTAB+9	None
89	DSPTAB+10	None
90	DSPTAB+11	Defined in Table 224A-2

Table 224A-1 (Continued)

Word No.	Word Name	G&N 224A Processing Requirements
91	TIME2	Defined in Table 224A-2
92	TIME1	Defined in Table 224A-2
93	CHANNEL 11	Defined in Table 224A-2
94	CHANNEL 12	Defined in Table 224A-2
95	CHANNEL 13	Defined in Table 224A-2
96	CHANNEL 14	None
97	CHANNEL 30	Defined in Table 224A-2
98	CHANNEL 31	Defined in Table 224A-2
99	CHANNEL 32	Defined in Table 224A-2
100	CHANNEL 33	Defined in Table 224A-2

TABLE 224A-2

WORD NO.	WORD NAME	BITS	DATA MANIPULATION See Notes (-)	DISPLAY	SCALE FACTOR
3	PIPAX	1-15	CONVERT TO DECIMAL	PIPAX±XXXXX	1
4	PIPAY	1-15	CONVERT TO DECIMAL	PIPAY±XXXXX	1
5	PIPAZ	1-15	CONVERT TO DECIMAL	PIPAZ±XXXXX	1
6	BMAGY	1-15	CONVERT TO DECIMAL	BMAGX±XXXXX	1
7	BMAGX	1-15	CONVERT TO DECIMAL	BMAGY±XXXXX	1
8	BMAGZ	1-15	CONVERT TO DECIMAL	BMAGZ±XXXXX	1
23	IMODES30	1	(a)	IGN PIP FAIL ON (OFF)	N/A
23	IMODES 30	2	NONE	N/A	
23	IMODES30	3	(a)	IGN ICDU FAIL ON (OFF)	N/A
23	IMODES30	4	(a)	IGN IMU FAIL ON (OFF)	N/A
23	IMODES30	5	NONE	N/A	N/A
23	IMODES30	6	(a)	INITIALIZE ISS ON (OFF)	N/A
23	IMODES30	7-15	NONE	N/A	N/A
27	CDUX	1-15	(j)	CDUX XXX. XX DEG	N/A
28	CDUY	1-15	(j)	CDUY XXX. XX DEG	N/A
29	CDUZ	1-15	(j)	CDUZ XXX. XX DEG	N/A
31	CDUT	1-15	(j)	CDUT XX. XXX DEG	N/A
32	CDUS	1-15	(j)	CDUS XXX. XX DEG	N/A
37	REDOCTR	1-15	CONVERT TO DECIMAL	REDOCTR XXXXX	1
38	FAILREG	1-15	DISPLAY IN OCTAL	FAILREG XXXXX	N/A
39	OPTMODES	1	NONE	N/A	N/A
39	OPTMODES	2	(a)	IGN OCDU FAIL ON (OFF)	N/A
39	OPTMODES	3	(a)	OPT ZEROING ON (OFF)	N/A
39	OPTMODES	4-5	(c)	OPT SWITCH XXX	N/A
39	OPTMODES	6-15	NONE	N/A	N/A
51	DRIFTO	1-15	CONVERT TO DECIMAL	V DRIFTO±XXX. XX MERU	$1000/2^{14}$
53	DRIFTI	1-15	CONVERT TO DECIMAL	S DRIFTI±XXX. XX MERU	$1000/2^{14}$
55	DRIFTT	1-15	CONVERT TO DECIMAL	E DRIFTT±XXX. XX MERU	$1000/2^{14}$
59	ANGZ	1-15	CONVERT TO DECIMAL	ANGZ±. XXXXX	$1/2^{14}$

TABLE 224A-2

WORD NO.	WORD NAME	BITS	DATA MANIPULATION See Notes (-)	DISPLAY	SCALE FACTOR
61	ANGY	1-15	CONVERT TO DECIMAL	ANGY±. XXXXX	$1/2^{14}$
63	ANGX	1-15	CONVERT TO DECIMAL	ANGX±. XXXXX	$1/2^{14}$
73	PIPAN	1-15	CONVERT TO DECIMAL	PIPAN±XXXXX	1
75	PIPAE	1-15	CONVERT TO DECIMAL	PIPAE±XXXXX	1
77	UPLOCK	1	(a) (d)	UPLOCK ON (OFF)	N/A
77	UPLOCK	2-15	NONE	N/A	N/A
90	DSTAB+11	1-3	NONE	N/A	N/A
90	DSTAB+11	4	(a)	NO ATTITUDE ON (OFF)	N/A
90	DSTAB+11	5	NONE	N/A	N/A
90	DSTAB+11	6	(a) (d)	GIMBAL LOCK ON (OFF)	N/A
90	DSTAB+11	7	NONE	N/A	N/A
90	DSTAB+11	8	(a)	TRACKER FAIL ON (OFF)	N/A
90	DSTAB+11	9	(a)	PROGRAM ALM ON (OFF)	N/A
90	DSTAB+11	10-15	NONE	N/A	N/A
91	TIME 2 (MS)	1-15	(e) (f) CONVERT	CMC TIME XXXX HRS XX MIN	1/360,000
92	TIME 1 (LS)	1-15	TO DECIMAL	XX. XX SEC	
93	CHNL 11	1	(a)	ISS WARNING ON (OFF)	N/A
93	CHNL 11	2	(b)	COMPUTER	N/A
93	CHNL 11	3	(b)	UPLINK	N/A
93	CHNL 11	4	(a)	TEMP CAUTION ON (OFF)	N/A
93	CHNL 11	5	(a)	KEY RELEASE ON (OFF)	N/A
93	CHNL 11	6	(a) (g)	FLASH VERB-NOUN ON (OFF)	N/A
93	CHNL 11	7	(a) (h)	OPERATOR ERR ON (OFF)	N/A
93	CHNL 11	8-12	NONE	N/A	
93	CHNL 11	13	(a)	ENGINE ON ON (OFF)	N/A
93	CHNL 11	14-15	NONE	N/A	N/A
94	CHNL 12	1	(a)	ZERO OPT CDUS ON (OFF)	N/A
94	CHNL 12	2	(a)	ABL OPT ER CTR ON (OFF)	N/A
94	CHNL 12	3	NONE	N/A	N/A
94	CHNL 12	4	(a)	COARSE ALIGN ON (OFF)	N/A
94	CHNL 12	5	(a)	ZERO ICDUS ON (OFF)	N/A

TABLE 224A-2 (Continued)

WORD NO.	WORD NAME	BITS	DATA MANIPULATION See Notes (-)	DISPLAY	SCALE FACTOR
94	CHNL 12	6	(a)	IMU ERR CTR ON (OFF)	N/A
94	CHNL 12	7	NONE	N/A	N/A
94	CHNL 12	8	(a)	TVC ENABLE ON (OFF)	N/A
94	CHNL 12	9	(a)	SAT TAKOVR ABL ON (OFF)	N/A
94	CHNL 12	10-12	NONE	N/A	N/A
94	CHNL 12	13	(a)	SAT INJ SEQ ST ON (OFF)	N/A
94	CHNL 12	14	(a)	SAT CUTOFF ON (OFF)	N/A
94	CHNL 12	15	(a)	ISS TRNON COMP ON (OFF)	N/A
95	CHNL 13	1-4	NONE	N/A	N/A
95	CHNL 13	5	(a)	INHIBIT UPLINK ON (OFF)	N/A
95	CHNL 13	6-7	NONE	N/A	N/A
95	CHNL 13	8	(a)	BMAG CTR ABL ON (OFF)	N/A
95	CHNL 13	9	NONE	N/A	N/A
95	CHNL 13	10	(a)	TEST ALARMS ON (OFF)	N/A
95	CHNL 13	11	(a)	ABL CMC STBY ON (OFF)	N/A
95	CHNL 13	12-15	NONE	N/A	N/A
97	CHNL 30	1	(a)	ULLAGE OFF (ON)	N/A
97	CHNL 30	2	(a)	SM SEPARATE OFF (ON)	N/A
97	CHNL 30	3	(a)	SPS READY OFF (ON)	N/A
97	CHNL 30	4	(a)	SIVB SEP/ABT OFF (ON)	N/A
97	CHNL 30	5	(a)	LIFTOFF OFF (ON)	N/A
97	CHNL 30	6	(a)	GUIDNCE REF RL OFF (ON)	N/A
97	CHNL 30	7	(a)	OPT CDU FAIL OFF (ON)	N/A
97	CHNL 30	8	NONE	N/A	N/A
97	CHNL 30	9	(a)	IMU OPERATE OFF (ON)	N/A
97	CHNL 30	10	(a)	S/C CTL SATURN OFF (ON)	N/A
97	CHNL 30	11	(a)	IMU CAGE OFF (ON)	N/A
97	CHNL 30	12	(a)	ISS CDU FAIL OFF (ON)	N/A
97	CHNL 30	13	(a)	IMU FAIL OFF (ON)	N/A
97	CHNL 30	14	(a)	ISS TRNON RQST OFF (ON)	N/A
97	CHNL 30	15	(a)	TEMP IN LIM OFF (ON)	N/A

TABLE 224A-2 (Continued)

WORD NO.	WORD NAME	BIT	DATA MANIPULATION See Notes (-)	DISPLAY	SCALE FACTOR
98	CHNL 31	1	(a)	+PITCH MAN ROT OFF (ON)	N/A
98	CHNL 31	2	(a)	-PITCH MAN ROT OFF (ON)	N/A
98	CHNL 31	3	(a)	+YAW MAN ROT OFF (ON)	N/A
98	CHNL 31	4	(a)	-YAW MAN ROT OFF (ON)	N/A
98	CHNL 31	5	(a)	+ROLL MAN ROT OFF (ON)	N/A
98	CHNL 31	6	(a)	-ROLL MAN ROT OFF (ON)	N/A
98	CHNL 31	7	(a)	+X TRANS OFF (ON)	N/A
98	CHNL 31	8	(a)	-X TRANS OFF (ON)	N/A
98	CHNL 31	9	(a)	+Y TRANS OFF (ON)	N/A
98	CHNL 31	10	(a)	-Y TRANS OFF (ON)	N/A
98	CHNL 31	11	(a)	+Z TRANS OFF (ON)	N/A
98	CHNL 31	12	(a)	-Z TRANS OFF (ON)	N/A
98	CHNL 31	13-14	NONE	N/A	N/A
98	CHNL 31	15	(a)	G/N CONTROL OFF (ON)	N/A
99	CHNL 32	1	(a)	+PITCH MIN IMP OFF (ON)	N/A
99	CHNL 32	2	(a)	-PITCH MIN IMP OFF (ON)	N/A
99	CHNL 32	3	(a)	+YAW MIN IMP OFF (ON)	N/A
99	CHNL 32	4	(a)	-YAW MIN IMP OFF (ON)	N/A
99	CHNL 32	5	(a)	+ROLL MIN IMP OFF (ON)	N/A
99	CHNL 32	6	(a)	-ROLL MIN IMP OFF (ON)	N/A
99	CHNL 32	7-10	NONE	N/A	N/A
99	CHNL 32	11	(a)	LM ATTACHED OFF (ON)	N/A
99	CHNL 32	12-15	NONE	N/A	N/A
100	CHNL 33	1-9	NONE	N/A	N/A
100	CHNL 33	10	(a)	BLOCK UPLINK OFF (ON)	N/A
100	CHNL 33	11	(a)	UPLINK TOO FAST OFF (ON)	N/A
100	CHNL 33	12	NONE	N/A	N/A
100	CHNL 33	13	(a)	PIPA FAIL OFF (ON)	N/A
100	CHNL 33	14	(a)	CMC WARNING OFF (ON)	N/A
100	CHNL 33	15	(a)	OSC ALARM OFF (ON)	N/A

TABLE 224A-2 (continued)

Notes:

a) If the bit indicated equals 1, display the word underlined. If the bit indicated equals 0, display the word parenthesis.

b) If the bit indicated equals 1, set the SGS discrete that displays the word in the display column. If the bit equals 0, remove the appropriate SGS discrete.

c) Display the following:

BIT 4	BIT 5	"XXX" DISPLAY
0	0	OFF
0	1	ZER
1	0	CMC
1	1	MAN

d) Store bit STATUS for G&N 631.

e) Combine the 14 magnitude bits of the most significant part (MS) with 14 magnitude bits of the least significant part (LS). The decimal conversion should be made only after the two parts of the double precision word have been sign checked. The signs appear in bit 15 of each word.

f) Store values of TIME 1, TIME 2 and RANGE TIME for G&N 602.

g) Store bit status for G&N 622A and G&N 632.

h) Store bit status for G&N 631.

i) Treat CDUT as an unsigned 15 bit counter. If $CDUT_8$ is greater than or equal to 61740_8, form $CDUT_8 - 61740_8$, convert to decimal, and multiply by $90°/2^{15}$. Display result as CDUT. If $CDUT_8$ is less than 61740_8, form $CDUT_8 + 61740_8$, convert to decimal and multiply by $90°/2^{15}$. Display result as CDUT.

j) Treat this word as an unsigned 15 Bit counter, convert to decimal and multiply by $360/2^{15}$.

Title: GC Clock Initialization Program G&N 601

Part Of: Mission Initialization and GC Alignment Program

Purpose: This program sets the GC clock registers TIME 1 and TIME 2 equal to some predetermined preset value at a given Range Time.

The purposes of G&N 601 are as follows:

A. To insert into the GC clock registers a predetermined preset value of time at a given range time.

B. Insert in GC erasable memory a double precision value of Time-to-Epoch, when required.

C. Prepare inputs for G&N 602

NOTE: The uplink transmission (Noun-Verb sequence) format will be the same for the primary and secondary functions of this specification.

Calling Sequence:

A. Enter Range Time (T_{RP}) for insertion of the GC clock preset value by the following C-START entry:

1) Windows 10-9 insert 90
2) Windows 8-7 insert XX hours of T_{RP}
3) Windows 6-5 insert XX minutes of T_{RP}
4) Windows 4-2 insert XXX seconds of T_{RP} (to the nearest tenth)
5) Window 1 insert 0

B. Insert the GC clock preset value as follows:

1) Windows 10-9 insert 91
2) Windows 8-5 insert ±XXX hours of E_p
3) Windows 4-3 insert XX minutes of E_p
4) Windows 2-1 insert XX seconds of E_p

C. Insert the first GC address of the time registers into which the preset value E_p is to be stored, also enter the constant K for G&N 602. This C-START entry is:

1) Windows 10-9 insert 70

2) Windows 8-4 insert YYYYY the 5 digit GC octal address for the time registers.

3) Windows 3-1 insert XXX milleseconds for K.

D. Enter the Epoch time, T_E, that is to be stored in the GC.

1) Windows 10-9 insert 80

2) Windows 8-5 insert ± XXX hours of T_E

3) Windows 4-3 insert XX minutes of T_E

4) Windows 2-1 insert XX seconds of T_E

E. Enter the GC octal address, LOC, into which T_E is to be stored.

1) Windows 10-9 insert 71

2) Windows 8-4 insert YYYYY octal address LOC.

3) Windows 3-1 insert 000

F. Call up G&N 601 through the R-START Module specified in the PRPS.

Input Data:

T_{R_1} - Range Time maintained in ACE-S/C computer.

E_p - Preset time to be inserted in GC clock.

T_{RP} - Range time at which E_p is to be inserted.

T_E - Time to Epoch when required.

Normal Exit: Uplink Transmission to the GC and temporary storage of the following quantities.

K - transmission delays to be supplied jointly by AC and G.E.

T_{HRS} - Range time truncated to hrs.

T_{R_1} - Range time

E_p - Preset time

Error Exit: None.

Computation Sequence: The following sequence should occur:

1) When Range Time, T , is equal to T_{RP}, the quantities E_p and the GC address for the time registers are transmitted uplink using the commands listed under Uplink Commands.

2) If LOC is not equal to zero, then the quantities T_E and LOC are transmitted uplink using the commands listed under Uplink Commands.

3) Store the following items for inputs into G&N 602:

T_{R_1} - Range time, which is also equal to T_{RP}

E_p - Preset time

T_{HRS} - The value of T_{R_1}, truncated to hours

K - constant to be used in G&N 602

4) All uplink commands are to be time tagged and filed on the Uplink File Tape.

5) Before the double precision words E_p and T_E are transmitted uplink they must be converted to double precision words which have a least significant bit of 10 millesecond value.

		Key Code Complement	
1	XXXXX	XXXXX	XXXXX
	5 Bit Keycode		5 Bit Keycode

Figure 601-1

Command Uplink: All uplink transmissions per Figure 601-1 will be as follows·

1	10001	01110	10001	(VERB)
1	00010	11101	00010	(2)
1	00100	11011	00100	(4)
1	11111	00000	11111	(NOUN)
1	10000	01111	10000	(0)
1	00001	11110	00001	(1)
1	11100	00011	11100	(ENTER)
1	$0_1 0_1 0_1 0_1 0_1$	$\overline{0_1 0_1 0_1 0_1 0_1}$	$0_1 0_1 0_1 0_1 0_1$	(DIGIT 1, OCTAL ADDRESS)
1	$0_2 0_2 0_2 0_2 0_2$	$\overline{0_2 0_2 0_2 0_2 0_2}$	$0_2 0_2 0_2 0_2 0_2$	(DIGIT 2, OCTAL ADDRESS)
1	$0_3 0_3 0_3 0_3 0_3$	$\overline{0_3 0_3 0_3 0_3 0_3}$	$0_3 0_3 0_3 0_3 0_3$	(DIGIT 3, OCTAL ADDRESS)
1	$0_4 0_4 0_4 0_4 0_4$	$\overline{0_4 0_4 0_4 0_4 0_4}$	$0_4 0_4 0_4 0_4 0_4$	(DIGIT 4, OCTAL ADDRESS)
1	$0_5 0_5 0_5 0_5 0_5$	$\overline{0_5 0_5 0_5 0_5 0_5}$	$0_5 0_5 0_5 0_5 0_5$	(DIGIT 5, OCTAL ADDRESS)
1	11100	00011	11100	(ENTER)
1	$0_1 0_1 0_1 0_1 0_1$	$\overline{0_1 0_1 0_1 0_1 0_1}$	$0_1 0_1 0_1 0_1 0_1$	(DIGIT 1, WORD 1)
1	$0_2 0_2 0_2 0_2 0_2$	$\overline{0_2 0_2 0_2 0_2 0_2}$	$0_2 0_2 0_2 0_2 0_2$	(DIGIT 2, WORD 1)
1	$0_3 0_3 0_3 0_3 0_3$	$\overline{0_3 0_3 0_3 0_3 0_3}$	$0_3 0_3 0_3 0_3 0_3$	(DIGIT 3, WORD 1)
1	$0_4 0_4 0_4 0_4 0_4$	$\overline{0_4 0_4 0_4 0_4 0_4}$	$0_4 0_4 0_4 0_4 0_4$	(DIGIT 4, WORD 1)
1	$0_5 0_5 0_5 0_5 0_5$	$\overline{0_5 0_5 0_5 0_5 0_5}$	$0_5 0_5 0_5 0_5 0_5$	(DIGIT 5, WORD 1)
1	11100	00011	11100	(ENTER)
1	$0_1 0_1 0_1 0_1 0_1$	$\overline{0_1 0_1 0_1 0_1 0_1}$	$0_1 0_1 0_1 0_1 0_1$	(DIGIT 1, WORD 2)
1	$0_2 0_2 0_2 0_2 0_2$	$\overline{0_2 0_2 0_2 0_2 0_2}$	$0_2 0_2 0_2 0_2 0_2$	(DIGIT 2, WORD 2)
1	$0_3 0_3 0_3 0_3 0_3$	$\overline{0_3 0_3 0_3 0_3 0_3}$	$0_3 0_3 0_3 0_3 0_3$	(DIGIT 3, WORD 2)
1	$0_4 0_4 0_4 0_4 0_4$	$\overline{0_4 0_4 0_4 0_4 0_4}$	$0_4 0_4 0_4 0_4 0_4$	(DIGIT 4, WORD 2)
1	$0_5 0_5 0_5 0_5 0_5$	$\overline{0_5 0_5 0_5 0_5 0_5}$	$0_5 0_5 0_5 0_5 0_5$	(DIGIT 5, WORD 2)
1	11100	00011	11100	(ENTER)
1	11001	00110	11001	(KEYBOARD RELEASE)

Verify: Each Uplink Transmission is to be verified via CSR Verify response. A non-verify response should be indicated by a CRT display of "TIME ERROR 1".

Store: T_{R_1}, E_p, T_{HRS}, and K for inputs to G&N 602

CRT Display: "TIME EPOCH XXX HRS XX MINS XX.XXX SECS"

Operator Action: Console Operator: When Clock Initialization Program is desired, perform the C-START entries before R-START call-up of G&N 601 is made. Make sure there is no other major Uplink Activity at this time.

Spacecraft Operator: No activity required.

Uplink Requirements: See COMPUTATION SEQUENCE.

Downlink Requirements: Measurement ID: Not applicable.

Tolerance: Not applicable.

Remarks: Definition of terms used in this subprogram are as follows:

T_{R_1} - Range Time (hrs, mins, secs, ms)

E_p - Preset time for GC clock (hrs, mins, secs, ms)

T_{RP} - Range time at which E_p is to be inserted (hrs, mins, secs, ms).

T_E - Time to Epoch (hrs, mins, secs, ms)

K - Transmission delays (ms)

LOC - Location (octal) of address in erasable GC memory.

T_{HRS} - Range time truncated to Hrs.

Title: GC Time Verification Program G&N 602

Part Of: Mission Initialization and GC Alignment Program

Purpose: This program is designed to align the GC time clock to the Range Time reference. This program calculates the time alignment Δt which is to be added algebraically to the GC clock register TIME1 and TIME2 to correct for transmission delays in loading and reading these registers.

Calling Sequence: Call-up through the R-START Module specified in the PRPS or PRD.

Inputs:

T_{R_1} = from G&N 601 - Range time of initiation (hrs, mins, secs, ms)

T_{HRS} = Range time truncated to Hrs from G&N 601

K = Transmission delays from G&N 601

E_P = Preset time inserted in GC Clock from G&N 601

T_A = Time from G&N 624 or 224

T_{R_2} = Range Time of GC time receipt

Normal Exit: Display Δt in seconds.

Error Exit: Display error sources as specified.

Computation Sequence:

Compute $\Delta t = (T_{R_2} - T_{R_1}) - (T_A - E_P) - K$

Note: See explanatory flow chart of Δt calculation (Figure 602-1) and explanation of computations in "Remarks" section.

Display: Δt (in seconds, decimal) in the following format:

"DELTA TIME ± XXX.XXX SECS"

Store: Δt as input to G&N 603

Test:

(1) If $|\Delta t| \geq 15$ minutes display "TIME ERROR 2".
If $|\Delta t| < 15$ minutes, continue.

(2) When T_A is sampled for G&N 602 sampling should not occur while the GC time registers in the Downlink Computer memory are being updated.

Since the Range Time is initialized every 24 hours, it is necessary to program a counter which contains the total hours from the initiation of G&N 601. A proposed flow chart for such a routine is given in Figure 602-1.

It should be noted that T_{R_2}, T_{R_1} and T_A can be broken down into units of hours, minutes, seconds and milliseconds. The compare statements in Figure 602-1 use only units of hours which are truncated.

Operator Action:

Console Operator: When time verification program is desired, call up is made through R-START Module activation.

Spacecraft Operator: No activity required.

Uplink Requirements:

Transmission to GC: None

DTCS Stimuli Location: Not Applicable

Time of Transmission: Not Applicable

Downlink Requirements:

Measurement ID: Measurement No. G 0001V

Tolerance:

If program fails Δt test, indicate failure by display indicated under TEST in "Computations" section and return to Uplink Control Program.

Failure of program to execute because of no GC time available should be indicated by "TIME ERROR 4" and exit should be made to Uplink Control Program.

The accuracy of Δt is to be 10 milliseconds.

Filing Requirements:

During System Tests a recording of T_{R_1}, T_{R_2}, E_P, T_A, K, $T_{R_{HRS}}$, $T_{R_{2(HRS)}}$ and DCNT should be made.

Remarks:

Definition of terms used in this subprogram are as follows:

T_{R_1} - Range time from G&N 601 in hrs, mins, secs, ms.

T_{HRS} - Range time from G&N 601 truncated to hrs.

K = Transmission delays from G&N 601 in ms.

E_P = Present Time insert in LGC clock from G&N 601, in hrs, mins, secs, ms.

T_A - GC time from G&N 224 or G&N 624 in hrs, mins, secs, ms.

T_{R_2} - Range time of GC time receipt in hrs, mins, secs, ms.

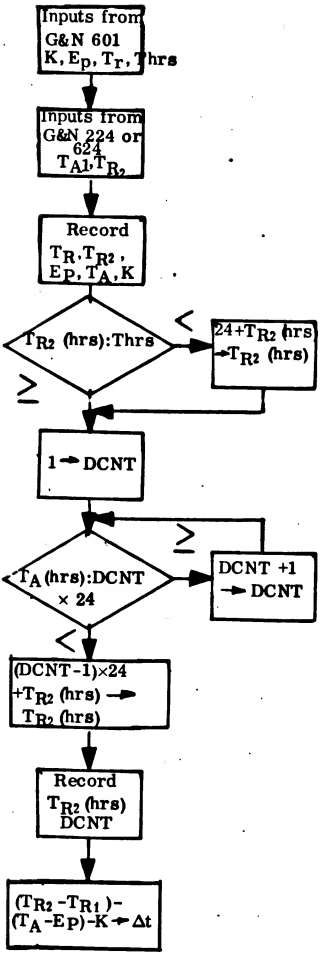

Inputs from G&N 601 K, E_p, T_r, Thrs
Inputs from G&N 224 or 624 T_{A1}, T_{R_2}
Record T_R, T_{R^2}, E_P, T_A, K
T_{R_2} (hrs):Thrs
<
24+T_{R_2} (hrs) → T_{R_2} (hrs)
≥
1 → DCNT
T_A (hrs):DCNT × 24
≥
DCNT +1 → DCNT
<
(DCNT-1)×24 +T_{R_2} (hrs) → T_{R_2} (hrs)
Record T_{R_2} (hrs) DCNT
(T_{R_2} - T_{R_1}) - (T_A - Ep) - K → Δt

Figure 602-1

Title: GC Time Correction G&N 603

Part Of: Mission Initialization and GC Clock Alignment Program

Purpose: This program adds, algebraically, the differential time correction, Δt, to the GC clock to align it to Range Time. This program formats and transmits through the GC Uplink the Δt which is then added to the GC to complete the alignment. G&N 601 and 602 must have been successfully executed before G&N 603 is executed.

Calling Sequence: Entry: Call-up through the R-START Module specified in the PRPS or PRD.

Input: Δt from G&N 602

Normal Exit: Display Δt as per G&N 602. Return to Uplink Control Program.

Error Exit: Display "TIME ERROR 3" to indicate Δt not transmitted or incorrectly transmitted.

Computations Sequence:

1) Transmit Δt by the following Uplink Transmission. The format of the GC Uplink Transmission is given in Figure 603-1.

	Keycode Complement		
XXXXX	$\overline{\text{XXXXX}}$	XXXXX	
5 Bit Keycode		5 Bit Keycode	

Figure 603-1. . LGC UPLINK FORMAT

1	10001	01110	10001	(VERB)
1	00101	11010	00101	(5)
1	00101	11010	00101	(5)
1	11100	00011	11100	(ENTER)
1	SIGN	$\overline{\text{SIGN}}$	SIGN	(SIGN OF Δt)
1	$0_1 0_1 0_1 0_1 0_1$	$\overline{0_1 0_1 0_1 0_1 0_1}$	$0_1 0_1 0_1 0_1 0_1$	(1st DIGIT OF Δt)
1	$0_2 0_2 0_2 0_2 0_2$	$\overline{0_2 0_2 0_2 0_2 0_2}$	$0_2 0_2 0_2 0_2 0_2$	(2nd DIGIT OF Δt)
1	$0_3 0_3 0_3 0_3 0_3$	$\overline{0_3 0_3 0_3 0_3 0_3}$	$0_3 0_3 0_3 0_3 0_3$	(3rd DIGIT OF Δt)
1	$0_4 0_4 0_4 0_4 0_4$	$\overline{0_4 0_4 0_4 0_4 0_4}$	$0_4 0_4 0_4 0_4 0_4$	(4th DIGIT OF Δt)
1	$0_5 0_5 0_5 0_5 0_5$	$\overline{0_5 0_5 0_5 0_5 0_5}$	$0_5 0_5 0_5 0_5 0_5$	(5th DIGIT OF Δt)
1	11100	00011	11100	(ENTER)
1	11001	00110	11001	(KEYBOARD RELEASE)

Verify: Each Uplink Word Transmission by using appropriate Uplink Verification Program. Indicate transmission failure by CRT display "TIME ERROR 3".

Operator Action: Console Operator: When G&N 603 is desired, call-up is made through R-START Module activation.

Spacecraft Operator: No activity required.

Uplink Requirements:

See "Computations" Sequence.

DTCS Stimuli Location: not applicable

Time of Transmission: no requirement

Filing Requirements: All information transmitted should be recorded on Uplink Command File Tape.

Downlink Requirements:

Measurement ID: not applicable.

CRT Display: See Exits under Calling Sequence.

Processing Category: See Program No. G&N 602

Remarks: This mode requires previous calculation of Δt by G&N 602. The sign and five most significant digits are transmitted uplink.

Title: Guidance Computer Downlink Format Program G&N 621

Part Of: Downlink Program

Purpose: The LGC transmits blocks of five 8-bit words into the PCM T/M at a 50 block per second rate. These data blocks represent a complete cycle through one LGC Downlist. The Downlist consists of a fixed length of 100 LGC words, each data block representing 2 of these words. Several lists are specified for LEM Block II, where the list address contained in the ID word identifies the transmitted parameters.

The Downlink Format subprogram accepts each block of five 8-bit words, verifies parity, and reformats each word into a 16-bit format. The type of LGC word represented is identified and the word is routed to other ACE-S/C subprograms for subsequent processing.

Calling Sequence: Entry: This subprogram operates under Downlink Executive Program control and is initiated by receipt of an Executive program interrupt.

Data: 1) A sequence of 50 blocks of five 8-bit words during 1 second.

2) Notification upon loss of a block (prime frame) or sequence of 50 blocks (sub-frame).

Normal Exit: Valid data is transmitted to the appropriate ACE-S/C subprogram for further processing and display.

Error Exit: Error conditions will be displayed on the CRT and recorded on the Downlink file tape. A search for an ID word to enable further data processing, occurs under certain error conditions. The CRT error displays are detailed in Table 621-2.

Computation Sequence:

The program receives blocks of five 8-bit words, configured as follows:

WORD 1	WOC	S/15	14	13	12	11	10	9
WORD 2	8	7	6	5	4	3	2	1
WORD 3	P	S/15	14	13	12	11	10	9
WORD 4	8	7	6	5	4	3	2	1
WORD 5	P	X	X	X	X	X	X	X

where WOC = Word order code (1 bit)
P = Odd parity (LGC word)
X = 0 as presently configured

The data block contains 2 LGC 16-bit data or DSPTAB words, except where an ID word is encountered. The individual word formats are specified below. The LGC data word includes a parity (P) and sign (S) bit. (See Figure 621-1.

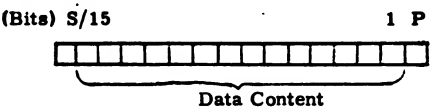
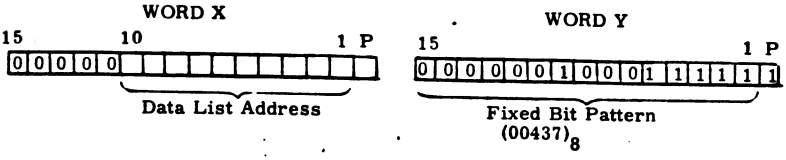


Figure 621-1

The DSPTAB word format is essentially as specified in Figure 621-1, as far as this program is concerned.

The identification (ID) word format contains five leading zeros with bits 1-10 containing the data list address. The complete ID word format is:



Word X precedes Word Y in the data block transmittal (Word 1 - Word 5). The Word order code (WOC) bit contains a 1 for all data and DSPTAB words, and a 0 for the ID word. The position of the LGC word in the fixed length list determines whether the word is to be processed for data monitoring or for DSKY display monitoring. Table 621-1 contains the specified Downlink lists which initiate the operation of this program.

Basically, Program G&N 621 receives PCM data blocks, checks parity, and determines the word type, to allow the transfer of 16-bit words to ACE-S/C programs for subsequent processing. A word count is utilized to detect any deviation from the normal list transmission. A block count is also utilized to indicate if both words in the data block have been processed and so allow the reading in of another block.

When an error is sensed, display and recording of pertinent information takes place and depending upon the type of error, control is transferred to point C in the flow chart (Figure 621-2) where a search for an ID word is initiated.

If a DSPTAB word is detected, then bit 15 is checked for a '1' indication. If a '1' is encountered the word must be complemented prior to transmitting the word to G&N 622 for further processing. Upon detection of an ID word, the data list address is transmitted to G&N 624 to allow that program to utilize the correct display format and scaling information. Figure 621-2 is given as a representative flow, to convey the intent of the subprogram operation.

Operator Action: Console Operator: No activity required.

Spacecraft Operator: No activity required.

Uplink Requirements: Not applicable

Downlink Requirements: Filing: Upon detection of an error the appropriate information is recorded on the Downlink file tape as specified in the flow chart and Table 621-2. [illegible] as the Downlink [illegible] is removed.

Display: This information is detailed in the flow chart and consists of program error displays as specified in Table 621-2. The ACE requirements specification contains the CRT page and line information.

Table 621-1

BASIC DOWNLIST FORMAT

WORDCNT	DATA	Five-Word BLOCK	WORDCNT	DATA	Five-Word BLOCK
1 and 2	ID	1	87 88	DSPTAB +8 DSPTAB +9	44
3 - 76	37 DP words, the data contents of which are specified by the ID list address	2 - 38	89 90	DSPTAB +10 DSPTAB +11	45
77 78	UPLOCK T6LOC	39	91 92	TIME 2 TIME 1	46
79 80	DSPTAB +0 DSPTAB +1	40	93 94	(Channel 11) (Channel 12)	47
81 82	DSPTAB +2 DSPTAB +3	41	95 96	(Channel 13) (Channel 14)	48
83 84	DSPTAB +4 DSPTAB +5	42	97 98	(Channel 30) (Channel 31)	49
85 86	DSPTAB +6 DSPTAB +7	43	99 100	(Channel 32) (Channel 33)	50

Four ID groups shall be accepted as valid by this program:

Downlist No.	Word 1_8	Word 2_8
1	00321	00437
2	01610	00437
3	00253	00437
4	00001	00437

Table 621-2

Error Description	CRT Display	File Tape Listing
This indicates that Wordcnt has incremented beyond a specified limit, with no ID word detected.	SYNCERR 1	621, SYNCERR1, Time Tag Reference, WORDCOUNT, 5 word block
At this point Wordcnt should be 101, if an ID has been received in the correct sequence.	SYNCERR 2	621, SYNCERR 2, Time Tag reference, WORDCOUNT, 5-word block.
Parity is incorrect in the first LGC word in data block.	WORDERR 1	621, WORDERR1, Time Tag reference, 5 word block, WORDCOUNT.
Parity is incorrect in the second LGC word in data block.	WORDERR 2	621, WORDERR 2, Time Tag reference, 5 word block, WORDCOUNT.
ID word (bits 11 - 15) $\neq (00)_8$	WORDERR 3	621, WORDERR 3, Time Tag reference, 5 word block, WORDCOUNT.
Fixed bit pattern in ID word is illegal.	WORDERR 4	621, WORDERR 4, Time Tag reference, 5 word block, WORDCOUNT.
Invalid list address encountered after attempting to utilize second LGC word to identify ID word.	WORDERR 5	621, WORDERR 5, Time Tag reference, 5 word block, WORDCOUNT
Invalid list address encountered in the first LGC word in data block.	WORDERR 6	621, WORDERR 6, Time Tag reference, 5 word block, WORDCOUNT.
Parity is incorrect in ID word.	WORDERR 7	WORDCOUNT, 5 word block WORDERR 7, Time tag ref.

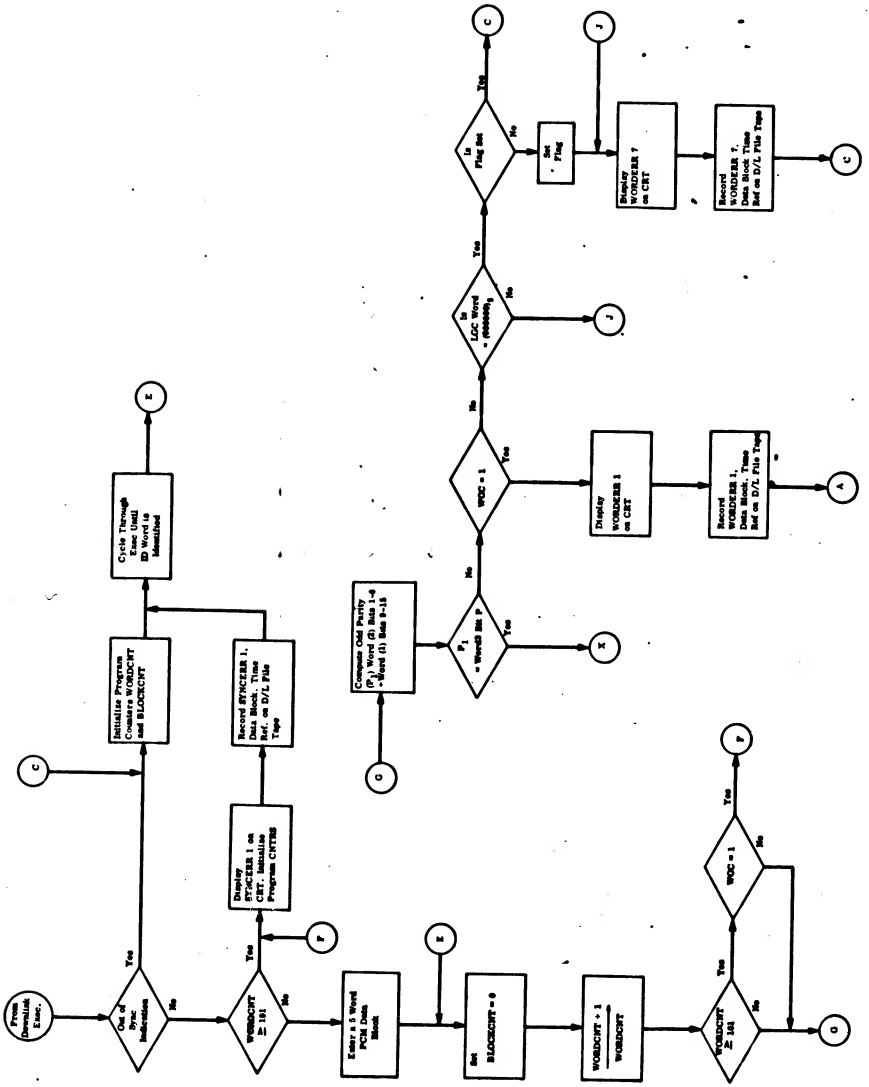


Figure 621-2 (1 of 3)

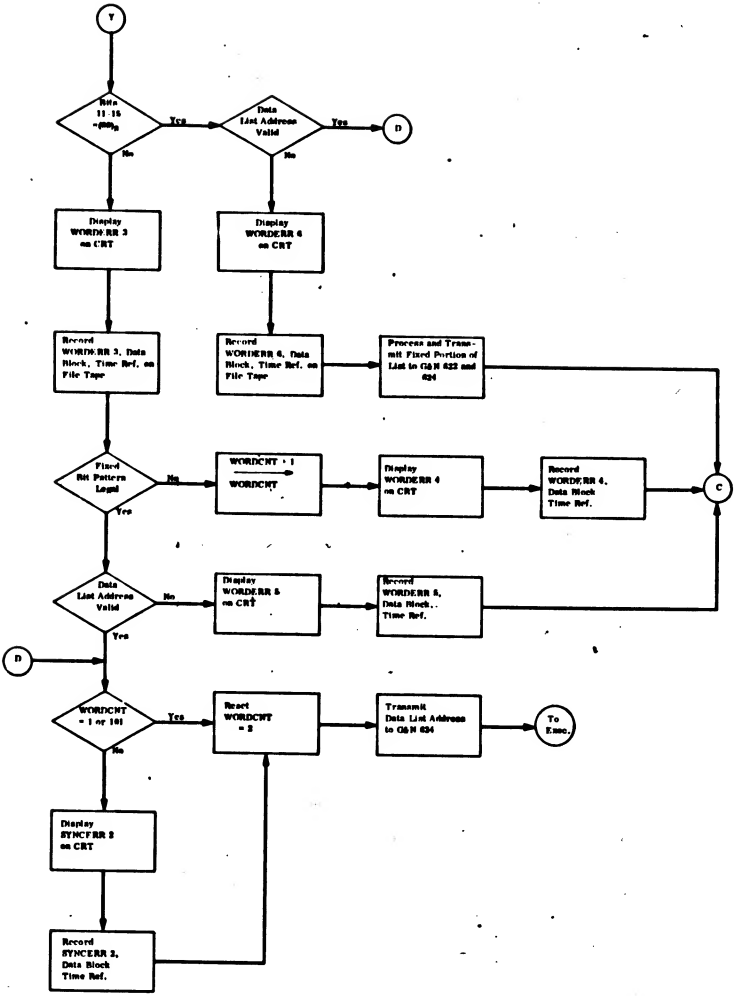


Figure 621-2 (2 of 3)

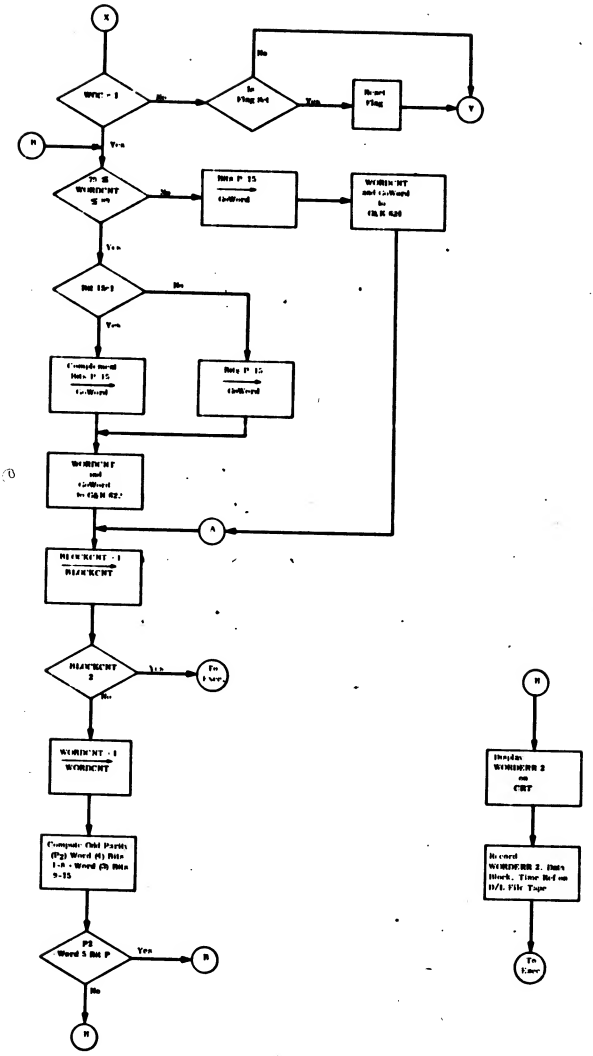


Figure 621-2 (3 of 3)

Title: Guidance Computer Downlink Format Subprogram G&N 621-200

Part Of: Downlink Program

Purpose: The subprogram accepts each block of five 8-bit T/M words (LGC Data), reformats the block into two 16-bit LGC words and checks parity. A check for the correct data sequence and a valid ID Block is also made. After these checks, the 16-bit LGC words are routed to the appropriate subprograms for further processing. If any of the checks fail, an error flag is set.

Calling Sequence: Entry: This subprogram operates under Downlink Executive Program Control and is initiated upon receipt of an Executive Program interrupt.

Data: Input - (a) A sequence of 100 blocks of five 8-bit T/M words over a 2 second period (2 sub-frames).

(b) Notification upon loss of a block (Prime Frame).

Output - (a) Valid data is transmitted to the appropriate ACE-S/C Subprogram (G&N 622-200 or G&N 624-200) for further processing and display.

(b) Error conditions will be displayed on the CRT and recorded on the file tape.

Normal Exit: Return to Executive Program Control.

Error Exit: None

Computation Sequence: General:

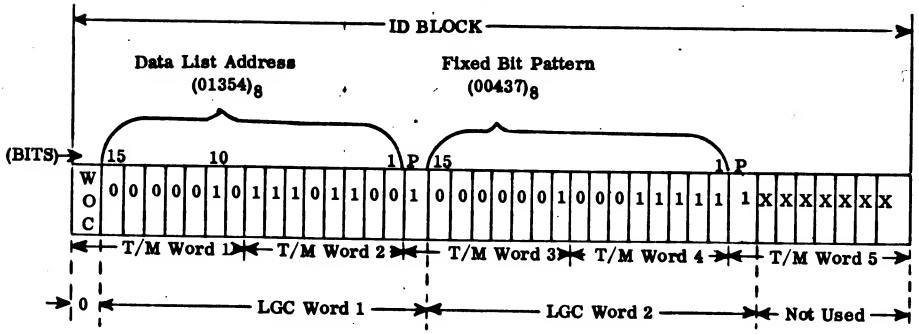
The program receives blocks of five 8-bit T/M words, with the following configurations:

WORD 1	WOC	15	14	13	12	11	10	9
WORD 2	8	7	6	5	4	3	2	1
WORD 3	P	15	14	13	12	11	10	9

WORD 4	8	7	6	5	4	3	2	1
WORD 5	P	X	X	X	X	X	X	X

Where WOC = Word order code (1-bit)
P = Parity (LGC word has odd parity)
X = Not used

The ID block should normally appear once every 100 prime frames and contains a zero WOC, two LGC 16-bit words including parity bits (P) and seven unused bit positions (X). LGC word 1 contains the data list address in bit positions 15-1 and parity (P) in bit position zero. LGC Word 2 contains a fixed bit pattern sync word $(00437)_8$ in bit positions 1-15 and Parity (P) in bit position zero. LGC Word 1 precedes LGC Word 2 in the data block transmission. The word order code (WOC) bit contains a 0 for all LGC ID blocks. An example block and word formats is shown below.



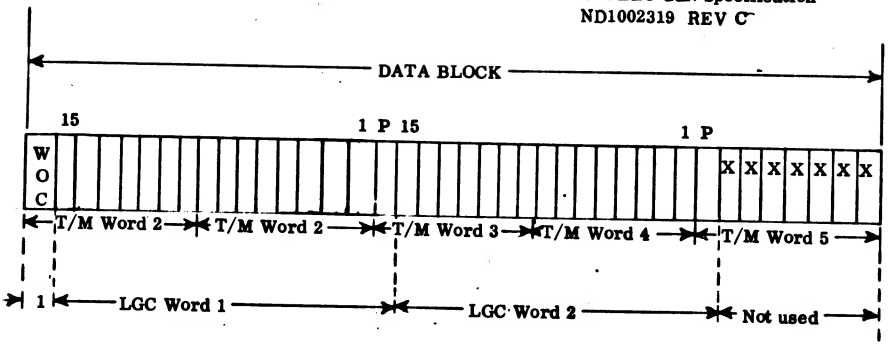
The following ID groups shall be accepted as valid:

Downlist No.	(ID Word)8	(SYNC Word)8	Table No.
1	01354	00437	621-200-1

The data blocks (normally 99 between ID blocks) contain a WOC, two LGC 16-bit words including parity bits (P) and seven unused bit positions (X).

LGC Word 1 precedes LGC Word 2 in the data block transmission. The word order code (WOC) bit contains a 1 for all LGC Data Blocks. The block and word formats are specified as follows:

621-200.2



The 200 word LGC downlist content is specified in applicable Table referenced by the ID word. The position of the LGC word in the fixed length list determines whether the word is to be routed for data monitoring (G&N 624-200) or for DSKY display monitoring (G&N 622-200).

Logic Sequence

1. Upon initial entry, for a Decom loss of sync (LOS) or under conditions as specified in steps 3 and 4 below, wait for an ID block which has a word order code of 0 then initialize a word counter. If no requirement for this step, proceed to step 2.

2. Under normal conditions or successful completion of step 1 above, check parity of both the 1st and 2nd LGC words of the block. If this check fails, display WORD ERR 1 on the CRT and file WORD ERR 1 with the information defined under filing requirements and proceed to step 3.

3. For a WOC = 0, perform ID check for:

 a. Correct data list address in bits 1-15 of 1st LGC word in the ID block.

 b. $(00437)_8$ in bits 1-15 of the 2nd LGC word in the ID block.

 If either of the above checks fail, display WORD ERR 2 on the CRT and file WORD ERR 2 with information defined under filing requirements. Return to wait routine specified in step 1 above.

 If ID check passes, check that an ID block has not been received too soon.

 If it has been received too soon, display SYNCERR 2 on the CRT and file SYNCERR 2 with the information defined under filing requirements and proceed as if it had been in the correct sequence. If the ID block is received in the correct sequence, initialize the word count for processing data blocks and return to Exec.program control.

4. For a WOC≠0, check, use word count, to see if an ID was expected. If it was display SYNCERR 1 on the CRT and file SYNCERR 1 with the information defined under Filing Requirements. Return to 'wait routine' specified in step 1 above. If no ID block was expected, proceed to step 5.

5. DSPTAB words +0 thru +10D are to be sent to G&N 622-200 along with the word count after taking the ones complement of the DSPTAB word if bit 15 is a one (1). All other words with the exception of the ID word and SYNC word are to be sent to G&N 624-200 for processing.

6. When LGC power is off,all bits in the data block will be zero causing a constant WORDERR 1 and IDERR 1. If this condition exists, the error should be filed only once per minute.

Operator Action

Console operator: No activity required.

Spacecraft operator: No activity required.

Uplink Requirements Not applicable.

Downlink Requirements:

CRT Display: This information is detailed in the computational sequence description and consists of program error displays as specified in Table 621-200-2. The ACE requirements specification contain the CRT page and line information.

Tolerance: Not applicable.

Measurement ID: GG 0001

Filing: Upon detection of an error, the appropriate information is recorded on the file tape as specified in Table 621-200-2.

TABLE 621-200-1

DOWNLIST NO. 1

BLOCK	WRD CNT	LGC WRD 1	WRD CNT	LGC WRD 2	WOC
1	1	DOWNLIST ID (01354-OCTAL)	2	SYNC BITS (00437-OCTAL)	0
2	3	STATE VEC X POS MSB AVE-G	4	STATE VEC X POS LSB AVE-G	1
3	5	STATE VEC Y POS MSB AVE-G	6	STATE VEC Y POS LSB AVE-G	1
4	7	STATE VEC Z POS MSB AVE-G	8	STATE VEC Z POS LSB AVE-G	1
5	9	STATE VEC X VEL MSB AVE-G	10	STATE VEC X VEL LSB AVE-G	1
6	11	STATE VEC Y VEL MSB AVE-G	12	STATE VEC Y VEL LSB AVE-G	1
7	13	STATE VEC Z VEL MSB AVE-G	14	STATE VEC Z VEL LSB AVE-G	1
8	15	STATIME MSB	16	STATIME LSB	1
9	17	GARBAGE	18	DESIRED CDU X	1
10	19	DESIRED CDUY	20	DESIRED CDU Z	1
11	21	DELV X MSB	22	DELV X LSB	1
12	23	DELV Y MSB	24	DELV Y LSB	1
13	25	DELV Z MSB	26	DELV Z LSB	1
14	27	LMP CMD	28	LMP CMD+1	1
15	29	LMP CMD+2	30	LMP CMD+3	1
16	31	LMP CMD+4	32	LMP CMD+5	1
17	33	LMP CMD+6	34	LMP CMD+7	1
18	35	LMP IN	36	LMP OUT	1
19	37	SPARE	38	SPARE	1
20	39	UPVERB	40	COMPNUMB	1
21	41	STATE COUNT	42	UPOLDMOD	1
22	43	ST BUFF +0	44	ST BUFF +1	1
23	45	ST BUFF +2	46	ST BUFF +3	1
24	47	ST BUFF +4	48	ST BUFF +5	1
25	49	ST BUFF +6	50	ST BUFF +7	1
26	51	ST BUFF +8D	52	ST BUFF +9D	1
27	53	ST BUFF +10D	54	ST BUFF +11D	1
28	55	ST BUFF +12D	56	ST BUFF +13D	1
29	57	I MODE 30	58	I MODE 33	1
30	59	TIME OF EVENT MSB	60	TIME OF EVENT LSB	1
31	61	FC MSB	62	FC LSB	1
32	63	AOSQ	64	AOSR	1
33	65	TIGN MSB	66	TIGN LSB	1
34	67	REDO COUNTER	68	S FAIL	1
35	69	GARBAGE	70	ACTUAL CDU X	1
36	71	ACTUAL CDU Y	72	ACTUAL CDU Z	1
37	73	OMEGA P	74	OMEGA Q	1
38	75	GARBAGE	76	OMEGA R	1
39	77	STATE	78	FLAGWORD 1	1
40	79	FLAGWORD 2	80	DAP BOOLS	1
41	81	CHANNEL 11	82	CHANNEL 12	1

TABLE 621-200-1 (Continued)
DOWNLIST NO. 1

BLOCK	WRD CNT	LGC WRD 1	WRD CNT	LGC WRD 2	WOC
42	83	CHANNEL 13	84	CHANNEL 14	1
43	85	CHANNEL 30	86	CHANNEL 31	1
44	87	CHANNEL 32	88	CHANNEL 33	1
45	89	DSPTAB +0	90	DSPTAB +1	1
46	91	DSPTAB +2	92	DSPTAB +3	1
47	93	DSPTAB +4	94	DSPTAB +5	1
48	95	DSPTAB +6	96	DSPTAB +7	1
49	97	DSPTAB +8D	98	DSPTAB +9D	1
50	99	DSPTAB +10D	100	DSPTAB +11D	1
51	101	TIME 2	102	TIME 1	1
52	103	COMPTORK MSB	104	COMPTORK +1 LSB	1
53	105	COMPTORK +2 MSB	106	COMPTORK +3 LSB	1
54	107	COMPTORK +4 MSB	108	COMPTORK +5 LSB	1
55	109	FAILREG	110	FAILREG +1	1
56	111	FAILREG +2	112	ALMCADR	1
57	113	ALMCADR +1	114	ERCOUNT	1
58	115	PIPA X	116	PIPA Y	1
59	117	PIPA Z	118	GARBAGE	1
60	119	STATE +4	120	GARBAGE	1
61	121	SPARE	122	SPARE	1
62	123	SPARE	124	SPARE	1
63	125	SPARE	126	SPARE	1
64	127	LMPCMD	128	LMPCMD +1	1
65	129	LMPCMD +2	130	LMPCMD +3	1
66	131	LMPCMD +4	132	LMPCMD +5	1
67	133	LMPCMD +6	134	LMPCMD +7	1
68	135	LMP IN	136	LMP OUT	1
69	137	SPARE	138	SPARE	1
70	139	MISSION PHASE REGISTER 4	140	MISSION PHASE REGISTER 3	1
71	141	MISSION PHASE REGISTER 2	142	MISSION PHASE REGISTER 1	1
72	143	MISSION TIME REGISTER 4	144	MISSION TIME REGISTER 3	1
73	145	MISSION TIME REGISTER 2	146	MISSION TIME REGISTER 1	1
74	147	PHASE NUM	148	1/PIPADT	1
75	149	TIME TO GO MSB	150	TIME TO GO LSB	1
76	151	BURN DATA	152	BURN DATA	1
77	153	BURN DATA	154	BURN DATA	1
78	155	BURN DATA	156	BURN DATA	1
79	157	BURN DATA	158	BURN DATA	1
80	159	BURN DATA	160	BURN DATA	1
81	161	BURN DATA	162	BURN DATA	1

TABLE 621-200-1 (Continued)
DOWNLIST NO. 1

BLOCK	WRD CNT	LGC WRD 1	WRD CNT	LGC WRD 2	WOC
82	163	BURN DATA	164	BURN DATA	1
83	165	BURN DATA	166	BURN DATA	1
84	167	BURN DATA	168	BURN DATA	1
85	169	GARBAGE	170	ACTUAL CDU X	1
86	171	ACTUAL CDU Y	172	ACTUAL CDU Z	1
87	173	OMEGA P	174	OMEGA Q	1
88	175	GARBAGE	176	OMEGA R	1
89	177	STATE	178	FLAGWORD 1	1
90	179	FLAGWORD 2	180	DAP BOOLS	1
91	181	CHANNEL 11	182	CHANNEL 12	1
92	183	CHANNEL 13	184	CHANNEL 14	1
93	185	CHANNEL 30	186	CHANNEL 31	1
94	187	CHANNEL 32	188	CHANNEL 33	1
95	189	DSPTAB +0	190	DSPTAB +1	1
96	191	DSPTAB +2	192	DSPTAB +3	1
97	193	DSPTAB +4	194	DSPTAB +5	1
98	195	DSPTAB +6	196	DSPTAB +7	1
99	197	DSPTAB +8D	198	DSPTAB +9D	1
100	199	DSPTAB +10D.	200	DSPTAB +11D	1

TABLE 621-200-2

ERROR DESCRIPTION	CRT DISPLAY	FILE TAPE
This indicates that Word Count has incremented beyond a specified limit, with no ID word detected.	SYNCERR 1	SYNCERR 1, Time Tag reference, Word Count ID block
At this point Word Count has not reached its specified limit, but an ID block has been received.	SYNCERR 2	SYNCERR 2, Time Tag Reference Word Count ID Block.
The content of the ID block is not correct.	WORDERR 2	WORDERR 2, Time Tag Reference, Word Count ID Block
Parity is incorrect in the 1st or 2nd LGC word of either an ID Block or a Data Block.	WORDERR 1	WORDERR 1, Time Tag Reference, Block Count ID or Data, Block containing the parity error.

Title: GC Display Program G&N 622A

Part Of: Downlink Program

Purpose: The GC Display Program interprets all GC Display words that are detected as such by the GC Downlink Format Program G&N X21 and generates CRT displays identical in content and format to the on-board spacecraft displays. This program provides ACE-S/C ground station test personnel the capability of continuously monitoring all spacecraft keyboard displays.

Calling Sequence: Entry: This program is activated only by the GC Downlink Format Program whenever it is processing Downlink data.

Data: Input: Inputs to the display program consist of a complete 16 bit AGC Downlink Display word.

Output: Outputs consist of coded CRT display information which will be available for input to the Symbol Generator System (SGS) memory.

Normal Exit: Normal exit will be a return to the ACE Executive Program so it can provide data for program G&N X21.

Error Exit: Error conditions will cause error information to be displayed on the CRT and recorded on the downlink file tape. After error recording, control is returned to the ACE Executive Program. Error messages are detailed in Table 622A-3.

Computation Sequence: Activation of the GC Display Program is attained via the GC Downlink Format Program, G&N X21. Inputs to this program will be two 8-bit words and a word count value from 79 to 89 inclusive. The word count specifies the position of the display word in the Downlink list which in turn is used to identify the specific format of the display word.

The two 8-bit words constitute a full 16-bit AGC Downlink Display word. The format of this word is shown in Figure 622A-1.

Display Words (Figure 622A-1) consist of four parts of coded information:

1. The address in bits 15-12 is not used in Block II.

Since the display words from the DSPTAB table are sequentially transmitted Downlink, the Downlink Format Program (G&N X21) will supply this subprogram a word count which will properly identify each display word as defined in Table 622A-1.

2. The special code in bit 11 specifies a particular discrete associated with the Display word.

3. Bits 10-6 and 5-1 represent Display Codes which are associated with specific Display Names. These codes specify the numeric character to be displayed according to Table 622A-2.

Example: A Display Word with a bit configuration as shown in Figure 622A-2 and a word count of 83 should cause the ACE Display Program to:

1. Select the Display Word corresponding to associated word count 83 according to Table 622A-1.

2. Set the sign of display register (R2) to plus, according to Table 622A-1.

3. Set digit 1 of display register (R2D1) to 3 according to Table 622A-2.

4. Set digit 2 of display register (R2D2) to 6 according to Table 622A-2.

The Display Program is activated by G&N X21 whenever display words are to be interpreted. Upon entry from G&N X21 the display program switches on the word count value to determine which of the 11 display words is to be interpreted and displayed.

Below is a brief description of the action to be taken on these display words. (See Figure 622A-3 for flow diagram).

WORD COUNT from 21	DISPLAY WORD ACTION
81, 87, 88 or 89	The special code bit (bitt 11), of these 4 display words, is meaningless, therefore control is transferred to program region 1.
86	Go to program region 2.
80, 83 or 85	Bit 11 of these display words is interpreted as follows:
bit 11 = 1	Set sign indicator of R to plus.
bit 11 = 0	Do not change the sign indicator of R.

WORD COUNT from 621	DISPLAY WORD ACTION
79, 82 or 84	Bit 11 of these display words is interpreted as follows:
bit 11 = 1	Set sign indicator of R to minus.
bit 11 = 0	Set sign indicator of R to blank.

In both cases the program continues to region 1.

NOTE: Words with word counts 84 and 85 set the sign of R1; words with word counts 82 and 83 set the sign of R2; words with word counts 79 and 80 set the sign of R3.

Region 1 - extracts the relay code corresponding to bits 10-6 of the Downlink word and checks it against Table 622A-2 for legality. If the code is legal the indicator is set to display the digit from Table 622A-2 followed by a transfer to Region 2. If the code is not legal clear the sign display indicator and initiate a relay-error exit.

Region 2 - extracts the relay code corresponding to bits 5-1 and checks it against Table 622A-2 for legality. If the code is legal the indicator is set to display the digit from Table 622A-2 followed by a return to the ACE Executive Program. If the code is not legal clear the sign and first digit display indicators and initiate a relay-error exit.

Filing Requirements: (Applicable only if the possible File separation is exceeded.)

Upon detection of an error the appropriate records should be made on the file tape. These are given in Table 622A-3.

An R-START is to be used to transcribe the entire display on the file tape. This R-START will be interrogated after the processing of the 11th display word (word count = 89). If the R-START is selected and the display has changed since the last recording, the entire display is to be recorded (including FLASH and UPLINK indicators). If either the R-START is not selected or the display has not changed, no recording should be made. The recording should be prefaced by '622A Display Recording'.

Display Requirements: The CRT Displays required in error conditions are given in Table 622A-3. They and the DSKY CRT displays will be formatted on the pages defined in the ACE Requirements Specification.

16 BIT GC DOWNLINK DISPLAY WORD

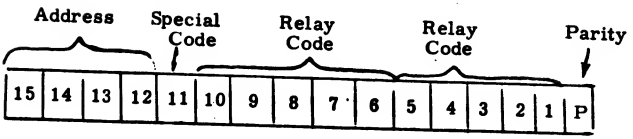


Figure 622A-1

DISPLAY WORD EXAMPLE

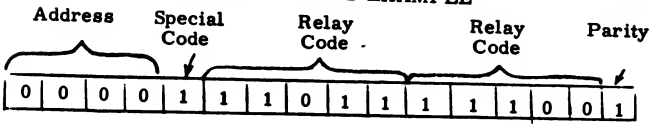


Figure 622A-2

Table 622A-1

Table of DISPLAY Words

Associated Word Count	Address Bits 15-12 Binary Code	Special Code Bit 11	Display Name Relay Code for Bits 10-6	Display Name Relay Code for Bits 5-1
89	N	--	MD1	MD2
88	O		VD1	VD2
87	T	--	ND1	ND2
86			--	R1D1
85	U	+ R1	R1D2	R1D3
84	S	- R1	R1D4	R1D5
83	E	+ R2	R2D1	R2D2
82	D	- R2	R2D3	R2D4
81		--	R2D5	R3D1
80		+ R3	R3D2	R3D3
79		- R3	R3D4	R3D5

Table 622A-2

5 Bit Relay Codes for Numeric Character Display

BLANK	00000
0	10101
1	00011
2	11001
3	11011
4	01111
5	11110
6	11100
7	10011
8	11101
9	11111

Table 622A-3

ERROR DESCRIPTION

ERROR	CRT DISPLAY	STANDARD MESSAGE ON FILE TAPE
A word has appeared containing a relay code which is not in Table 622A-2	RELERR1	622A RELERR1, 16-bit word, time tag, and ID code

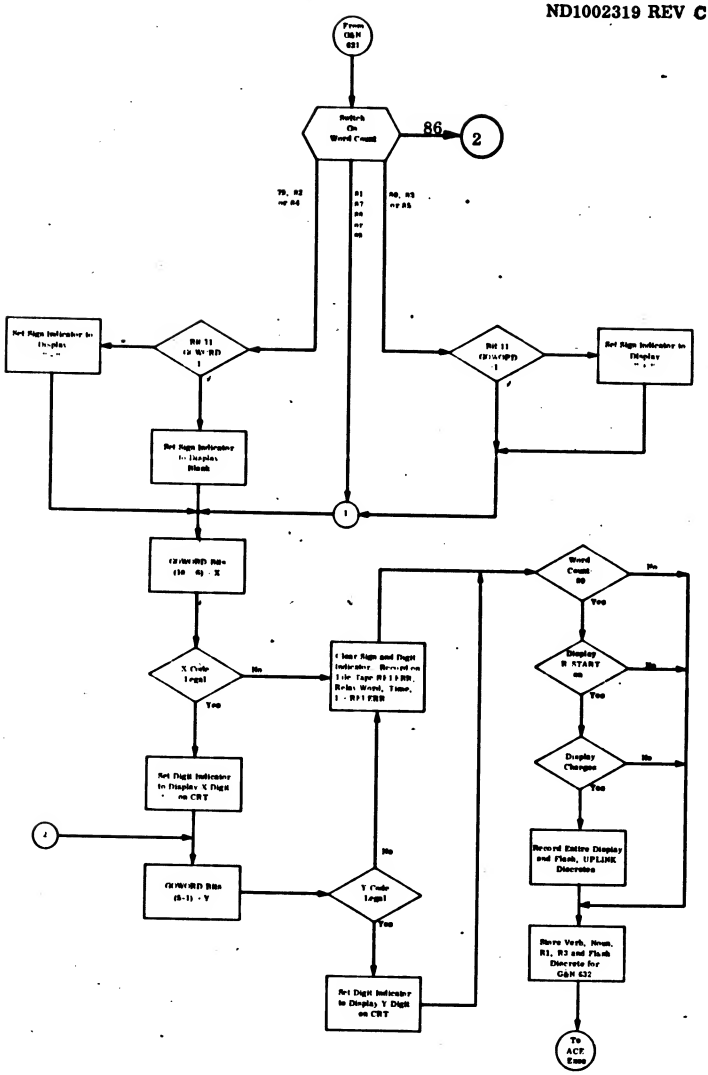


Figure 622A-3

Title: GC Display Program (DSPTAB) G&N 622-200

Part Of: Downlink Program

Purpose: The GC Display Program interprets all GC DSPTAB words that are detected as such by the GC Downlink Format Program and generates CRT displays identical in content and format to the on-board spacecraft displays. This program provides ACE-S/C ground station test personnel the capability of continuously monitoring all spacecraft keyboard displays.

Calling Sequence: Entry: This program is activated only by the GC Downlink Format Program whenever it is processing Downlink data.

Data: Input: Inputs to the display program consist of a complete 16 bit GC Downlink DSPTAB word.

Output: Outputs consist of coded CRT display information which will be available for input to the Symbol Generator System (SGS) memory.

Normal Exit: Normal exit will be a return to the ACE Executive Program.

Error Exit: Error conditions will cause error information to be displayed on the CRT and recorded on the file tape. After error recording, control is returned to the ACE Executive Program. Error messages are detailed in Table 622-200-3.

Computation Sequence: Activation of the GC Display Program is attained via the GC Downlink Format Program. Inputs to this program will be two 8-bit words and a word count. The word count specifies the position of the DSPTAB word in the Downlink list which in turn is used to identify the specific word format. There is a possibility that there can be more than one word count for a specific DSPTAB word. The GC Downlink Format Program will define word count/DSPTAB relationship.

The two 8-bit words constitute a full 16-bit GC Downlink DSPTAB word. The format of this word is shown in Figure 622-200-1 and consists of four parts of coded information as follows:

1. Bits 15-12: The address in these bits is not used.

2. Bit 11: The special code in this bit specifies a particular discrete associated with the DSPTAB word.

3. Bits 10-6: Represent Display Codes which are associated with specific Display Names. These codes specify the numeric character to be displayed according to Table 622-200-2.

4. Bits 5-1: Same as bits 10-6 above.

Since the contents of the DSPTAB table is sequentially transmitted Downlink, the GC Downlink Format Program will supply this subprogram with the DSPTAB contents (display word) and a word count associated with the DSPTAB. This word count will properly identify each DSPTAB. The display word associated with each DSPTAB is defined in Table 622-200-1.

Example: A 16-Bit GC Downlink Word with a specific word count, DSPTAB+4, and a bit configuration as shown in Figure 622-200-2 should cause the ACE Display Program To:

1. Select the Display Word corresponding to DSPTAB+4 according to Table 622-200-1.

2. Set the sign of display register (R2) to plus, according to Table 622-200-1

3. Set digit 1 of display register (R2D1) to 3 according to Table 622-200-2.

4. Set digit 2 of display register (R2D2) to 6 according to Table 622-200-2.

The Display Program is activated by the Downlink Format Program whenever display words are to be interpreted. Upon entry from the Downlink Format Program the display program switches on the word count value to determine which of the 11 DSPTAB words is to be interpreted and displayed.

The Logic sequence for the DSPTAB Words depends on the state of bit 11. Below is a brief description of the action to be taken.

DSPTAB	DSPTAB WORD ACTION
+2, +8D, +9D or +10D	The special code bit (bit 11), of these 4 DSPTAB words, is meaningless, therefore perform sequence 1 as described below
+7	Perform sequence 2 as described below:
+1, +4 or +6	Bit 11 of these DSPTAB words is interpreted as follows:
bit 11 = 1	Set sign indicator of R to plus.
bit 11 = 0	Do not change the sign indicator of R.
+0, +3 or +5	Bit 11 of these DSPTAB words is interpreted as follows:
bit 11 = 1	Set sign indicator of R to minus.
bit 11 = 0	Set sign indicator of R to blank.

In both cases the program performs sequence 1.

NOTE: With DSPTAB +5 and +6 set the sign of R1; DSPTAB +3 and +4 set the sign of R2; DSPTAB +0 and +1 set the sign of R3.

Sequence 1 - extracts the relay code corresponding to bits 10-6 of the Downlink word and checks it against Table 622-200-2 for legality. If the code is legal the indicator is set to display the digit from Table 622-200-2 followed by a transfer to sequence 2. If the code is not legal clear the sign display indicator and initiate a relay-error exit.

Sequence 2 - extracts the relay code corresponding to bits 5-1 and checks it against Table 622-200-2 for legality. If the code is legal the indicator is set to display the digit from Table 622-200-2 followed by a return to the ACE Executive Program. If the code is not legal, clear the sign and first digit display indicators and initiate a relay-error exit.

Filing Requirements: Upon detection of an error the appropriate records should be made on the file tape. These are given in Table 622-200-3.

An R-START is to be used to transcribe the entire display on the file tape. This R-START will be interrogated after the processing of the 11th display word. If the R-START is selected and the display has changed since the last recording, the entire display is to be recorded (including FLASH and UPLINK indicators).

If either the R-START is not selected or the display has not changed, no recording should be made. The recording should be prefaced by '622 Display Recording'.

Display Requirements: The CRT Displays required in error conditions are given in Table 622-200-3. They and the DSKY CRT displays will be formatted on the pages defined in the ACE Requirements Specification.

16 BIT GC DOWNLINK DISPLAY WORD

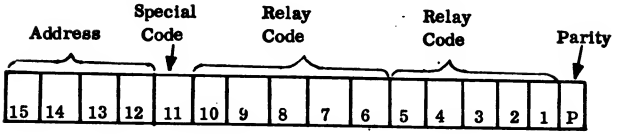


FIGURE 622-200-1

DISPLAY WORD EXAMPLE

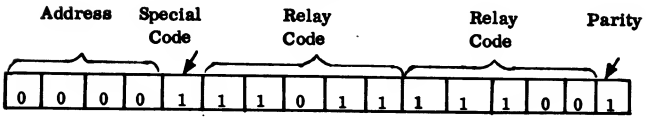


FIGURE 622-200-2

TABLE 622-200-1

TABLE OF DISPLAY WORDS

DSPTAB	Address Bits 15-12 Binary Code	Special Code Bit 11	Display Name Relay Code for Bits 10-6	Display Name Relay Code for Bits 5-1
+10D	N	- -	MD1	MD2
+ 9D	O	- -	VD1	VD2
+ 8D	T	- -	ND1	ND2
+ 7			- -	R1D1
+ 6	U	+R1	R1D2	R1D3
+ 5	S	-R1	R1D4	R1D5
+ 4	E	+R2	R2D1	R2D2
+ 3	D	-R2	R2D3	R2D4
+ 2		- -	R2D5	R3D1
+ 1		+R3	R3D2	R3D3
+ 0		-R3	R3D4	R3D5

TABLE 622-200-2

5 BIT RELAY CODES FOR NUMERIC CHARACTER DISPLAY

BLANK	00000
0	10101
1	00011
2	11001
3	11011
4	01111
5	11110
6	11100
7	10011
8	11101
9	11111

TABLE 622-200-3

ERROR DESCRIPTION

ERROR	CRT DISPLAY	STANDARD MESSAGE ON FILE TAPE
A word has appeared containing a relay code which is not in Table 622-200-2	RELERR1	622 RELERR1, 16-bit word, time tag, and word count

Title: LGC Downlink Interpretation Program, LEM G&N 624A

Part Of: Downlink Program

Purpose: This subprogram defines the interpretation of the LGC Downlink Data which is required for ACE-S/C console operator usage and information. Four downlists are to be processed by this subprogram for post-installation testing. The second word of the identification group for all downlists is identical, i.e., 00437_8. Lists with a first ID word of 00321_8 or 01610_8 shall be processed entirely as described in Table 624A-1. For lists with the first ID word 00253_8 or 00001_8, words 3 through 76 should not be processed, but words 1, 2, and 77 through 100 should be processed as described in Table 624A-1.

Calling Sequence: Entry: This subprogram is activated by the LGC Downlink Format Program, G&N 621, whenever the format Program is processing Downlink Data.

Data Input: Input from G&N 621 to the Downlink Interpretation Program consists of a 16-bit LGC Downlink Data Word. Two types of LGC words will be processed by G&N 624:

1) Identification: This word specifies the data list which is being received by G&N 624.

2) Data: Actual LGC data words. The position in the list identifies the data being processed.

Data Output: Output will consist of CRT displays and processed parameters stored in temporary buffers for use by other ACE-S/C G&N Subprograms.

Normal Exit: Return to ACE Executive Program which will supply more data to G&N 621.

Error Exit: None.

Computation Sequence: The downlink list for the LGC is transmitted once per second and consists of 100 words (two per prime frame). Each prime frame consists of five 8-bit PCM words which contain a 1-bit word order code, two 16-bit LGC words and seven extra (0) bits:

		BIT						
WORD 1	WOC	S/15	14	13	12	11	10	9
WORD 2	8	7	6	5	3	3	2	1
WORD 3	P	S/15	14	13	12	11	10	9
WORD 4	8	7	6	5	4	3	2	1
WORD 5	P	0	0	0	0	0	0	0

The Word Order Code (WOC) is 0 for an ID word and 1 for data words.

P is a Parity Bit

S is a Sign Bit

Table 624A-1 describes the contents of the list and provides the processing requirements for each word.

Operator Action: None

Uplink Requirements: None

Downlink Requirements: CRT Display: The ACE-S/C Programming Requirements Documents contain the CRT scope and line information associated with displays referenced in this subprogram specification.

Filing Requirements: None.

TABLE 624A-1

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION See Note ()	DISPLAY	SCALE FACTOR
1	ID	1-15	Display in OCTAL	IDWD1 XXXXX	N/A
2	ID	1-15	Display in OCTAL	IDWD2 XXXXX	"
3	PIPA X	1-15	Convert to Decimal	PIPA X ± XXXXX	1
4	PIPA Y	1-15	" " "	PIPA Y ± XXXXX	1
5	PIPA Z	1-15	" " "	PIPA Z ± XXXXX	1
6	RHCP	1-15	None	N/A	N/A
7	RADMODES	1	None	N/A	N/A
7	"	2	(b)	IGN RR CDU FAIL ON (OFF)	"
7	"	3	None	N/A	"
7	"	4	(a)	RR DATA FAIL ON (OFF)	"
7	"	5	(a)	LR ALT FAIL ON (OFF)	"
7	"	6-7	None	N/A	"
7	"	8	(a)	LR VEL FAIL ON (OFF)	"
7	"	9-10	None	N/A	"
7	"	11	(a)	RR ANT CUT ON (OFF)	"
7	"	12	(a)	RR ANT MODE 2 (1)	"
7	"	13	(b)	IGN RR CDU FAIL ON (OFF)	"
7	"	14	(a)	RR ANT REMD ON (OFF)	"
7	"	15	(a)	CONT DESIG ON (OFF)	"
8	SAMPLIN	1-15	None	N/A	"
9	OLDAT AGD	"	"	"	"
10	DESCOUNT	"	"	"	"
11	SAMPLSUM	"	"	"	"
12	" + 1	"	"	"	"
13	OPTYHOLD	"	"	"	"
14	" + 1	"	"	"	"
15	TIMEHOLD	"	"	"	"
16	" + 1	"	"	"	"
17	ALTTUDE	"	"	"	"
18	" + 1	"	"	"	"
19	ALTRATE	1-15	Convert to Decimal	ALT RATE ±XXXX.X FPS	0.5 FPS
20	FINALT	1-15	None	N/A	N/A
21	ALTSAVE (MS)	1-15	(c) Convert to Decimal	ALT SAVE ±XXXXXX.XXX FT	2.345 FT
22	ALTSAVE + 1(LS)	1-15			
23	FINALT (MS)	1-15	(c) Convert to Decimal	FIN ALT ±XXXXXX.XXX FT	2.345 FT
24	FINALT + 1 (LS)	1-15			
25	FORVEL	1-15	Convert to Decimal	FORVEL ±XXX.XX FPS	0.5571 FPS
26	LATVEL	1-15	Convert to Decimal	LATVEL ±XXX.XX FPS	0.5571 FPS
27	CDUX	1-15	" " "	CDUX ±XXX.XX DEG	$180/2^{14}$ DEG

TABLE 624A-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION (See Note ()	DISPLAY	SCALE FACTOR
28	CDU Y	1-15	Convert to Decimal	CDU Y ±XXX.XX DEG	$180/2^{14}$ DEG
29	CDU Z	1-15	" " "	CDU Z ±XXX.XX DEG	"
30	OPTY	1-15	None	N/A	N/A
31	RR TRUN	1-15	Convert to Decimal	RR TRUN ±XXX.XX DEG	$180/2^{14}$ DEG
32	RR SHAFT	1-15	" " "	RR SHAFT ±XXX.XX DEG	"
33	STATE	1-15	None	N/A	N/A
34	STATE + 1	1-15	"	"	"
35	STATE + 2	1-15	"	"	"
36	STATE + 3	1-15	"	"	"
37	REDO CTR	1-15	Convert to Decimal	REDO CTR XXXXX	1
38	FAIL REG	1-15	Display in Octal	FAIL REG XXXXX	N/A
39	LMPCMD	1-15	" " "	LMPCMD XXXXX	N/A
40	IMODES30	1	(d)	IGN PIP FAIL ON (OFF)	N/A
40	"	2	None	N/A	N/A
40	"	3	(a)	IGN I-CDU FAIL ON (OFF)	"
40	"	4	(a)	IGN IMU FAIL ON (OFF)	"
40	"	5	(d)	IGN PIP FAIL ON (OFF)	"
40	"	6	(a)	INITIALIZE ISS ON (OFF)	"
40	"	7-15	None	N/A	"
41	LAST Y CMD	1-15	None	N/A	"
42	LAST X CMD	1-15	"	"	"
43	TANG	1-15	"	"	"
44	TANG + 1	1-15	"	"	"
45	THETAD	1-15	"	"	"
46	THETAD + 1	1-15	"	"	"
47	THETAD + 2	1-15	"	"	"
48	DELVX	1-15	"	"	"
49	MARKSTAT	1-15	"	"	"
50	XY MARK	1-15	"	"	"
51	DRIFT 0	1-15	Convert to Decimal	VDRIFT 0 ±XXX.XX MERU	$1000/2^{14}$ MERU
52	DRIFT 0 + 1	1-15	None	N/A	N/A
53	DRIFT 1	1-15	Convert to Decimal	SDRIFT 1 ±XXX.XX MERU	$1000/2^{14}$ MERU
54	DRIFT 1 + 1	1-15	None	N/A	N/A
55	DRIFT 2	1-15	Convert to Decimal	EDRIFT 2 ±XXX.XX MERU	$1000/2^{14}$ MERU
56	DRIFT 2 + 1	1-15	None	N/A	N/A
57	TORQUE 0	1-15	None	N/A	N/A
58	TORQUE + 1	1-15	None	"	"
59	ANG Z	1-15	Convert to Decimal	ANG Z ±XXXXX	1.0

TABLE 624A-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION See Note ()	DISPLAY	SCALE FACTOR
60	ANG Z + 1	1-15	None	N/A	N/A
61	ANG Y/PIPA N		Display in Octal	ANG Y/PIPA N XXXXX	"
62	ANG Y + 1		None	N/A	"
63	ANG X/PIPA E		Display in Octal	ANG X/PIPA E XXXXX	"
64	ANG X + 1		None	N/A	"
65	V LAUN		None	N/A	"
66	V LAUN + 1		None	"	"
67	V LAUN + 4		None	"	"
68	V LAUN + 5		None	"	"
69	R STACK (MS)	1-15	(c),(e) Convert to Decimal	RR RANGE ±XXXXXXXXXX.XXX FT	+9.38 FT
70	R STACK + 1 (LS)	1-15		LR VX ±XXXXXXXXX.XXXXX FPS	+0.6435 FPS
71	R STACK + 6 (MS)	1-15	(c),(e) Convert to Decimal	RR RANGE RATE ±XXXXXXXXX. XXXX FPS	+0.6278 FPS
72	R STACK + 7 (LS)	1-15		LR VY ±XXXXXXXXX.XXXXX FPS	+1.2525 FPS
73	R STACK +12D (MS)	1-15	(c) Convert to Decimal	LR VZ ±XXXXXXXX.XXXXX FPS	+0.8571 FPS
74	R STACK +13D (LS)	1-15			
75	R STACK +18D (MS)	1-15			
76	R STACK +19D (LS)	1-15	(c) Convert to Decimal	LR ALT ±XXXXXXXXX.XXXXXFT	+1.079 FT
77	UPLOCK	1	(a)(f)	UPLOCK ON (OFF)	N/A
77	UPLOCK	2-15	None	N/A	N/A
78	T6LOC		None	"	"
79	DSPTAB + 0	1-15	"	"	"
80	DSPTAB + 1	1-15	"	"	"
81	DSPTAB + 2	1-15	"	"	"
82	DSPTAB + 3	1-15	"	"	"
83	DSPTAB + 4	1-15	"	"	"
84	DSPTAB + 5	1-15	"	"	"
85	DSPTAB + 6	1-15	"	"	"
86	DSPTAB + 7	1-15	"	"	"
87	DSPTAB + 8	1-15	"	"	"
88	DSPTAB + 9	1-15	"	"	"
89	DSPTAB + 10	1-15	"	"	"
90	DSPTAB + 11	1-3	None	"	"
90	DSPTAB + 11	4	(a)	NO ATTITUDE ON (OFF)	"
90	DSPTAB + 11	5	None	N/A	"
90	DSPTAB + 11	6	(a)(f)	GIMBAL LOCK ON (OFF)	"
90	DSPTAB + 11	7	None	N/A	"
90	DSPTAB + 11	8	(a)	TRACKER FAIL ON (OFF)	"

TABLE 624A-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION See Note ()	DISPLAY	SCALE FACTOR
90	DSPTAB + 11	9	(a)	PROGRAM ALARM ON (OFF)	N/A
90	DSPTAB + 11	10-15	None	N/A	"
91	TIME 2 (MS)	1-15	(g)(c)	LGC TIME XXXX.XXXXXX	1/360000
92	TIME 1 (LS)	1-15	Convert to Decimal		
93	CHNL 11	1	(a)	ISS WARNING ON (OFF)	N/A
93	"	2	(i)	COMPUTER	"
93	"	3	(i)	UPLINK	"
93	"	4	(a)	TEMP CAUTION ON (OFF)	"
93	"	5	(a)	KEY RELEASE ON (OFF)	"
93	"	6	(a)(h)	FLASH VERB-NOUN ON (OFF)	"
93	"	7	(a)(f)	OPERATOR ERROR ON (OFF)	"
93	"	8-12	None	N/A	"
93	"	13	(a)	ENGINE ON ON (OFF)	"
93	"	14	(a)	ENGINE OFF ON (OFF)	"
93	"	15	None	N/A	"
94	CHNL 12	1	(a)	ZERO RR CDUS ON (OFF)	"
94	"	2	"	RR ERR CNTR ON (OFF)	"
94	"	3	"	HORIZ VEL ON (OFF)	"
94	"	4	"	COARSE ALIGN ON (OFF)	"
94	"	5	"	ZERO ISS CDUS ON (OFF)	"
94	"	6	"	ISS ERR CNTR ON (OFF)	"
94	"	7	"	N/A	"
94	"	8	"	CDU CONTROL ON (OFF)	"
94	"	9	"	+ PITCH TRIM ON (OFF)	"
94	"	10	"	- PITCH TRIM ON (OFF)	"
94	"	11	"	+ ROLL TRIM ON (OFF)	"
94	"	12	"	- ROLL TRIM ON (OFF)	"
94	"	13	"	LR POS2 CMD ON (OFF)	"
94	"	14	"	RR LOCKON ABLE ON (OFF)	"
94	"	15	"	ISS TURNON COMP ON (OFF)	"
95	CHNL 13	1-4	None	N/A	"
95	"	5	(a)	INHIBIT UPLINK ON (OFF)	"
95	"	6-9	None	N/A	"
95	"	10	(a)	TEST ALARMS ON (OFF)	"
95	"	11	(a)	ABL LGC STBY ON (OFF)	"
95	"	12-15	None	N/A	"
96	CHNL 14	1	None	N/A	"
96	"	2	(a)	ALT RATE SEL ON (OFF)	"

TABLE 624A-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION See Note ()	DISPLAY	SCALE FACTOR
96	CHNL 14	3	(a)	ALT METER ACT ON (OFF)	N/A
96	"	4	(a)	THRUST DRV ON (OFF)	"
96	"	5-15	None	N/A	"
97	CHNL 30	1	(a)	ABORT OFF (ON)	"
97	"	2	"	STAGE VERIF OFF (ON)	"
97	"	3	"	ENG ARMED OFF (ON)	"
97	"	4	"	ABORT STAGE OFF (ON)	"
97	"	5	"	AUTO THROT OFF (ON)	"
97	"	6	"	DSP INRTL DATA OFF (ON)	"
97	"	7	"	RR CDU FAIL OFF (ON)	"
97	"	8	None	N/A	"
97	"	9	(a)(f)	IMU OPERATE OFF (ON)	"
97	"	10	(a)	G&N CNTL LEM OFF (ON)	"
97	"	11	"	IMU CAGE OFF (ON)	"
97	"	12	"	ISS CDU FAIL OFF (ON)	"
97	"	13	"	IMU FAIL OFF (ON)	"
97	"	14	"	ISS TURNON RQST OFF (ON)	"
97	"	15	"	TEMP IN LIM OFF (ON)	"
98	CHNL 31	1	(a)	+EL LPD, +PMI OFF (ON)	"
98	"	2	"	-EL LPD, -PMI OFF (ON)	"
98	"	3	"	+YMI OFF (ON)	"
98	"	4	"	-YMI OFF (ON)	"
98	"	5	"	+AZ LPD, +RMI OFF (ON)	"
98	"	6	"	-AZ LPD, -RMI OFF (ON)	"
98	"	7	"	+X TRANS OFF (ON)	"
98	"	8	"	-X TRANS OFF (ON)	"
98	"	9	"	+Y TRANS OFF (ON)	"
98	"	10	"	-Y TRANS OFF (ON)	"
98	"	11	"	+Z TRANS OFF (ON)	"
98	"	12	"	-Z TRANS OFF (ON)	"
98	"	13	"	ATTITUDE HOLD OFF (ON)	"
98	"	14	"	AUTO MODE OFF (ON)	"
98	"	15	"	ATT CNTR DETENT OFF (ON)	"
99	CHNL 32	1	(a)	JETS 2-4 FAIL OFF (ON)	"
99	"	2	"	JETS 5-8 FAIL OFF (ON)	"
99	"	3	"	JETS 1-3 FAIL OFF (ON)	"

TABLE 624A-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION See Note ()	DISPLAY	SCALE FACTOR
99	CHNL 32	4	(a)	JETS 6-7 FAIL OFF (ON)	N/A
99	"	5	"	JETS 14-16 FAIL OFF (ON)	"
99	"	6	"	JETS 13-15 FAIL OFF (ON)	"
99	"	7	"	JETS 9-12 FAIL OFF (ON)	"
99	"	8	"	JETS 10-11 FAIL OFF (ON)	"
99	"	9	"	PITCH GIM OFF (ON)	"
99	"	10	"	ROLL GIM OFF (ON)	"
99	"	11-15	None	N/A	"
100	CHNL 33	1	None	N/A	"
100	"	2	(a)	RR ON/AUTO OFF (ON)	"
100	"	3	"	RR RANGE LO-SC OFF (ON)	"
100	"	4	"	RR DATA GOOD OFF (ON)	"
100	"	5	"	LR ALT D GOOD OFF (ON)	"
100	"	6	"	LR POS 1 OFF (ON)	"
100	"	7	"	LR POS 2 OFF (ON)	"
100	"	8	"	LR VEL D GOOD OFF (ON)	"
100	"	9	"	LR ALT LO-SC OFF (ON)	"
100	"	10	"	BLOCK UPLINK OFF (ON)	"
100	"	11	"	UPLINK TOO FAST OFF (ON)	"
100	"	12	None	N/A	"
100	"	13	"	PIPA FAIL OFF (ON)	"
100	"	14	"	LGC WARNING OFF (ON)	"
100	"	15	"	OSC ALARM OFF (ON)	"

TABLE 624A-1 (Continued)

NOTES:

N/A - Not Applicable.

(a) - If the bit indicated equals one, display the word underlined. If the bit indicated equals zero, display the word in parentheses.

(b) - If either bit equals one, display the word underlined. If both bits are zero, display the word in parentheses.

(c) - Combine the 14 magnitude bits of the most significant (MS) part with 14 magnitude bits of the least significant part(LS). The decimal conversion should be made only after the two parts of the double precision word have been sign checked. The signs appear in bit 15 of each word. See "Remarks" for a method for handling double precision words.

(d) - Same as (b).

(e) - NOTE: This double precision word must be scaled two ways each of which is displayed.

(f) - Store bit status for G&N 631.

(g) - Store values for G&N 602.

(h) - Store bit status for G&N 622 and 632. If the indicated bit is a one, set the SGS Discrete for VERB-NOUN FLASH. If the bit is zero, clear the discrete.

(i) - If the bit indicated equals one, set the SGS Discrete that displays the word in the display column. If the bit equals zero, remove the appropriate SGS Discrete.

REMARKS:

Method of Handling Double Precision LGC Downlink Words

Figure 624A-1 is a flow diagram of a scheme for handling the double precision (DP) LGC downlink words. Each word consists of a sign bit (the high order bit), fourteen data bits and a parity bit (low order bit) for odd parity. The downlink words A and B may be in one of four conditions; plus zero (00000_8), minus zero (77777_8), positive non-zero or negative non-zero.

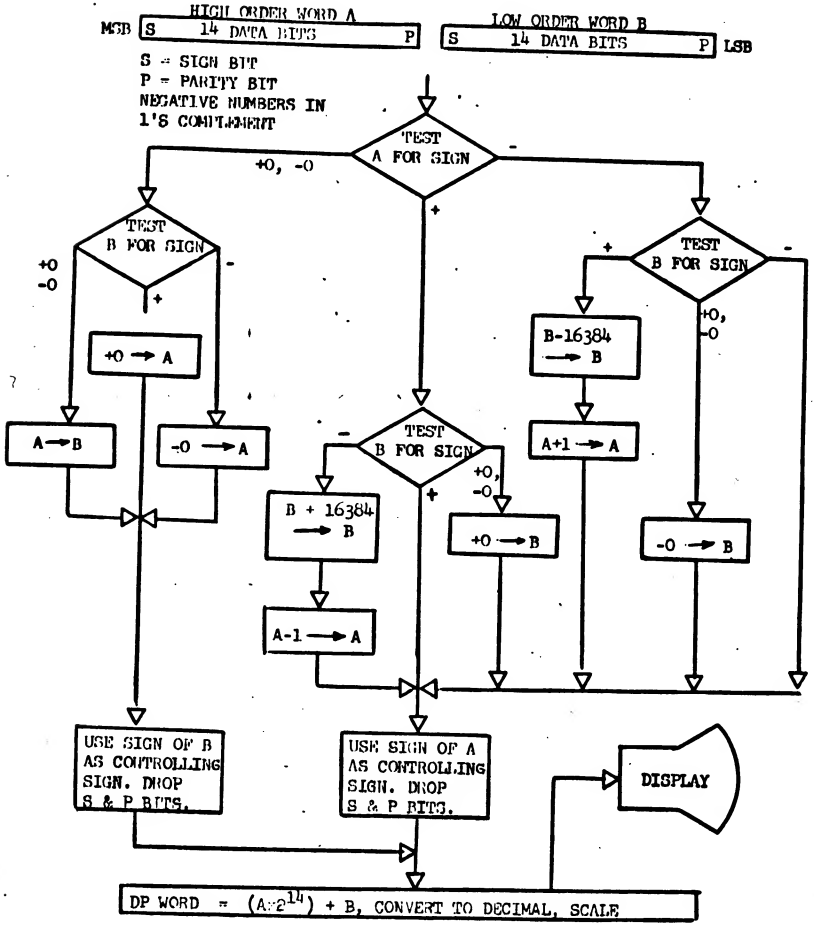
Tests are made on the sign and magnitude of A, and depending on the results, similar tests are made on B as outlined in Figure 624A-1. In the cases where A is plus or minus zero, the sign of B shall be the controlling sign.

In cases where A is non-zero and B is of opposite sign, the conversions to A and B are made as shown in Figure 624A-1, thereby forcing the sign of B to agree with the sign of A.

Prior to combining the DP words into a single quantity, the S and P bits are dropped. Converted B is then added to converted A X 2^{14}, and the resulting 28 bit word is converted to decimal, scaled and displayed on CRT with a sign as specified in the flow diagram.

FIGURE 624A-1

METHOD OF HANDLING DOUBLE PRECISION LGC DOWNLINK WORDS



Title: LGC Downlink Interpretation Program G&N 624B -

Part Of: Downlink Program

Purpose: This subprogram defines the interpretation of the LGC Downlink Data which is required for ACE-S/C Console operator usage and information. Four downlists are to be processed by this subprogram for post-installation testing. The second word of the identification group for all downlists is identical, i.e., 00437_8. Lists with a first ID word of 00321_8 or 01610_8 shall be processed entirely as described in Table 624B-1. For lists with the first ID word 00253_8 or 00001_8, words 2 through 76 should not be processed, but words 1 and 77 through 100 should be processed as described in Table 624B-1.

Calling Sequence: Entry: This subprogram is activated by the LGC Downlink Format Program, G&N 621, whenever the format Program is processing Downlink Data.

Data Input: Input from G&N 621 to the Downlink Interpretation Program consists of a 16-bit LGC Downlink Data Word. Two types of LGC words will be processed by G&N 624B:

1) Identification: This word specifies the data list which is being received by G&N 624B.

2) Data: Actual LGC data words. The position in the list identifies the data being processed.

Data Output: Output will consist of CRT displays and processed parameters stored in temporary buffers for use by other ACE-S/C G&N Subprograms.

Normal Exit: Return to ACE Executive Program which will supply more data to G&N 621.

Error Exit: None.

Computation Sequence: Table 624B-1 describes the contents of the list and provides the processing requirements for each word.

Operator Action: None.

Uplink Requirements: None.

Downlink Requirements: CRT Display: The ACE-S/C Programming Requirements Documents contain the CRT scope and line information associated with displays referenced in this subprogram specification.

Filing Requirements: Activation of the 'RECORD' R-START module function switch specified in the PRPS or PRD will cause the filing of a time tag and the following:

Octal Words: ID

Event Words: RADMODES, IMODES30, DSPTAB+11, CHNL 11, CHNL 12, CHNL 13, CHNL 14, CHNL 30, CHNL 31, CHNL 32, CHNL 33

Single Precision Words: REDOCTR, CDUX, CDUY, CDUZ, CDUS, CDUT, PIPAX, PIPAY, PIPAZ

Double Precision Words: (TIME 1, TIME 2)

TABLE 624B-1

WORD NUMBER	WORD NAME	BIT (S)	DATA MANIPULATION See Note ()	DISPLAY
1	ID	1-15	CTOCT	IDWD1 XXXX
3	PIPA X	1-15	CTDEC SF = 1	PIPA X ±XXXXX
4	PIPA Y	1-15	CTDEC SF = 1	PIPA Y ±XXXXX
5	PIPA Z	1-15	CTDEC SF = 1	PIPA Z ±XXXXX
6	RHCP	1-15	None	N/A
7	RADMODES	1	None	N/A
7	RADMODES	2	None	N/A
7	RADMODES	3	None	N/A
7	RADMODES	4	(a)	RR DATA FAIL ON ()
7	RADMODES	5	(a)	LR POS FAIL ON ()
7	RADMODES	6-7	None	N/A
7	RADMODES	8	(a)	LR VEL FAIL ON ()
7	RADMODES	9-10	None	N/A
7	RADMODES	11	(a)	RR ANT OUT ON ()
7	RADMODES	12	(a)	RR ANT MODE 2 (1)
7	RADMODES	13	None	N/A
7	RADMODES	14	(a)	RR ANT REMD ON ()
7	RADMODES	15	(a)	CONT DESIG ON ()
8	SAMPLIN	1-15	None	N/A
9	OLDAT AGD	1-15	None	N/A
10	DESCOUNT	1-15	None	N/A
11	SAMPLSUM	1-15	None	N/A
12	SAMPLSUM + 1	1-15	None	N/A
13	OPTYHOLD	1-15	None	N/A
14	OPTYHOLD + 1	1-15	None	N/A
15	TIMEHOLD	1-15	None	N/A
16	TIMEHOLD + 1	1-15	None	N/A
17	ALTITUDE	1-15	None	N/A
18	ALTITUDE + 1	1-15	None	N/A
19	ALTRATE	1-15	CTDEC SF = 0.5 FPS	ALT RATE ± XXXX.X FPS
20	FINALT	1-15	None	N/A

TABLE 624B-1 (Continued)

WORD NUMBER	WORD NAME	BIT (S)	DATA MANIPULATION See Note ()	DISPLAY
21	ALTSAVE (MS)	1-15	} (c) SF = 2.345 FT	ALT SAVE ±XXXXXXX. XXX FT
22	ALTSAVE + 1 (LS)	1-15		
23	FINALT (MS)	1-15	} (c) SF = 2.345 FT	FIN ALT ±XXXXXXX. XXX FT
24	FINALT + 1 (LS)	1-15		
25	FORVEL	1-15	CTDEC SF = 0.5571 FPS	FORVEL ±XXX. XX FPS
26	LATVEL	1-15	CTDEC SF = 0.5571 FPS	LATVEL ±XXX. XX FPS
27	CDUX	1-15	(k)	CDUX XXX. XX DEG
28	CDUY	1-15	(k)	CDUY XXX. XX DEG
29	CDUZ	1-15	(k)	CDUZ XXX. XX DEG
30	OPTY	1-15	None	N/A
31	RR TRUN	1-15	(k)	RR TRUN XXX. XX DEG
32	RR SHAFT	1-15	(k)	RR SHAFT XXX. XX DEG
33	STATE	1-15	None	N/A
34	STATE + 1	1-15	None	N/A
35	STATE + 2	1-15	None	N/A
36	STATE + 3	1-15	None	N/A
37	REDO CTR	1-15	CTDEC SF = 1	REDO CTR ±XXXXX
38	FAIL REG	1-15	CTOCT	FAIL REG XXXXX
39	LMPCMD	1-15	CTOCT	LMPCMD XXXXX
40	IMODES30	1	(a)	IGN PIP FAIL ON ()
40	IMODES30	2	None	N/A
40	IMODES30	3	(a)	IGN I-CDU FAIL ON ()
40	IMODES30	4	(a)	IGN IMU FAIL ON ()
40	IMODES30	6	(a)	INITIALIZE ISS ON ()
40	IMODES30	7-15	None	N/A
41	LAST Y CMD	1-15	None	N/A
42	LAST X CMD	1-15	None	N/A
43	TANG	1-15	None	N/A
44	TANG + 1	1-15	None	N/A
45	THETAD	1-15	None	N/A

TABLE 624B-1 (Continued)

WORD NUMBER	WORD NAME	BIT (S)	DATA MANIPULATION See Note ()	DISPLAY
46	THETAD + 1	1-15	None	N/A
47	THETAD + 2	1-15	None	N/A
48	DELVX	1-15	None	N/A
49	MARKSTAT	1-15	None	N/A
50	XY MARK	1-15	None	N/A
51	DRIFT 0	1-15	CTDEC SF = $1000/2^{14}$ MERU	VDRIFT 0 ±XXX.XX MERU
52	DRIFT 0 + 1	1-15	None	N/A
53	DRIFT 1	1-15	CTDEC SF = $1000/2^{14}$ MERU	SDRIFT I ±XXX.XX MERU
54	DRIFT 1 + 1	1-15	None	N/A
55	DRIFT 2	1-15	CTDEC SF = $1000/2^{14}$ MERU	EDRIFT T ±XXX.XX MERU
56	DRIFT 2 + 1	1-15	None	N/A
57	TORQUE 0	1-15	None	N/A
58	TORQUE + 1	1-15	None	N/A
59	ANG Z	1-15	CTDEC SF = 1	ANG Z ±XXXXX
60	ANG Z + 1	1-15	None	N/A
61	ANG Y/PIPA N	1-15	CTOCT	ANG Y/PIPA N XXXXX
62	ANG Y + 1	1-15	None	N/A
63	ANG X/PIPA E	1-15	CTOCT	ANG X/PIPA E XXXXX
64	ANG X + 1	1-15	None	N/A
65	V LAUN	1-15	None	N/A
66	V LAUN + 1	1-15	None	N/A
67	V LAUN + 4	1-15	None	N/A
68	V LAUN + 5	1-15	None	N/A
69	R STACK (MS)	1-15	(c), (e) SF = +9.38 FT	RR RANGE ±XXXXXXXXXX.XXX FT
70	R STACK + 1 (LS)	1-15	(c), (e) SF = +0.6435 FPS	LR VX ±XXXXXXXXX.XXX FPS
71	R STACK + 6 (MS)	1-15	(c), (e) SF = +0.6278 FPS	RR RANGE RATE ±XXXXXXXXX.XXX FPS
72	R STACK + 7 (LS)	1-15	(c), (e) SF = +1.2525 FPS	LR VY ±XXXXXXXXX.XXXXX FPS
73	R STACK +12D (MS)	1-15	(c) SF = +0.8571 FPS	LR VZ ±XXXXXXXXX.XXXXX FPS
74	R STACK +13D (LS)	1-15		
75	R STACK +18D (MS)	1-15	(c) SF = +1.079 FT	LR ALT ±XXXXXXXXX.XXXXX FT
76	R STACK +19D (LS)	1-15		

TABLE 624B-1 (Continued)

WORD NUMBER	WORD NAME	BIT (S)	DATA MANIPULATION See Note ()	DISPLAY
77	UPLOCK	1	(a) (f)	UPLOCK ON ()
77	UPLOCK	2-15	None	N/A
78	T6LOCK	1-15	None	N/A
79	DSPTAB + 0	1-15	None	N/A
80	DSPTAB + 1	1-15	None	N/A
81	DSPTAB + 2	1-15	None	N/A
82	DSPTAB + 3	1-15	None	N/A
83	DSPTAB + 4	1-15	None	N/A
84	DSPTAB + 5	1-15	None	N/A
85	DSPTAB + 6	1-15	None	N/A
86	DSPTAB + 7	1-15	None	N/A
87	DSPTAB + 8	1-15	None	N/A
88	DSPTAB + 9	1-15	None	N/A
89	DSPTAB + 10	1-15	None	N/A
90	DSPTAB + 11	1-3	None	N/A
90	DSPTAB + 11	4	(a)	NO ATTITUDE ON ()
90	DSPTAB + 11	5	None	N/A
90	DSPTAB + 11	6	(a) (f)	GIMBAL LOCK ON ()
90	DSPTAB + 11	7	None	N/A
90	DSPTAB + 11	8	(a)	TRACKER FAIL ON ()
90	DSPTAB + 11	9	(a)	PROGRAM ALARM ON ()
90	DSPTAB + 11	10-15	None	N/A
91	TIME 2 (MS)	1-15	(g) (c) SF = 1/360000	LGC TIME XXXX HRS XX MIN XX. XX SEC
92	TIME 1 (LS)	1-15		
93	CHNL 11	1	None	N/A
93	CHNL 11	2	(i)	COMPUTER
93	CHNL 11	3	(i)	UPLINK
93	CHNL 11	4	(a)	TEMP CAUTION ON ()
93	CHNL 11	5	(a)	KEY RELEASE ON ()
93	CHNL 11	6	(h)	FLASH VERB-NOUN ON ()

TABLE 624B-1 (Continued)

WORD NUMBER	WORD NAME	BIT (S)	DATA MANIPULATION See Note ()	DISPLAY
93	CHNL 11	7	(a) (f)	OPERATOR ERROR ON ()
93	CHNL 11	8-12	None	N/A
93	CHNL 11	13	(a)	ENGINE ON ON ()
93	CHNL 11	14	(a)	ENGINE OFF ON ()
93	CHNL 11	15	None	N/A
94	CHNL 12	1	(a) (j)	ZERO RR CDUS ON ()
94	CHNL 12	2	(a) (j)	RR ERR CNTR ON ()
94	CHNL 12	3	(a)	HORIZ VEL ON ()
94	CHNL 12	4	(a) (j)	COARSE ALIGN ON ()
94	CHNL 12	5	(a) (j)	ZERO ISS CDUS ON ()
94	CHNL 12	6	(a) (j)	ISS ERR CNTR ON ()
94	CHNL 12	7	None	N/A
94	CHNL 12	8	(a) (j)	CDU CONTROL ON ()
94	CHNL 12	9	(a)	+ PITCH TRIM ON ()
94	CHNL 12	10	(a)	- PITCH TRIM ON ()
94	CHNL 12	11	(a)	+ ROLL TRIM ON ()
94	CHNL 12	12	(a)	- ROLL TRIM ON ()
94	CHNL 12	13	(a)	LR POS2 CMD ON ()
94	CHNL 12	14	(a)	RR LOCKON ABLE ON ()
94	CHNL 12	15	(a)	ISS TURNON COMP ON ()
95	CHNL 13	1-4	None	N/A
95	CHNL 13	5	(a)	INHIBIT UPLINK ON ()
95	CHNL 13	6-9	None	N/A
95	CHNL 13	10	(a)	TEST ALARMS ON ()
95	CHNL 13	11	(a)	ABL LGC STBY ON ()
95	CHNL 13	12-15	None	N/A
96	CHNL 14	1	None	N/A
96	CHNL 14	2	(a)	ALT RATE SEL ON ()
96	CHNL 14	3	(a)	ALT METER ACT ON ()
96	CHNL 14	4	(a)	THRUST DRV ON ()

TABLE 624B-1 (Continued)

WORD NUMBER	WORD NAME	BIT (S)	DATA MANIPULATION See Note ()	DISPLAY
96	CHNL 14	5-15	None	N/A
97	CHNL 30	1	(a)	ABORT _____ (ON)
97	CHNL 30	2	(a)	STAGE VERIF _____ (ON)
97	CHNL 30	3	(a)	ENG ARMED _____ (ON)
97	CHNL 30	4	(a)	ABORT STAGE _____ (ON)
97	CHNL 30	5	(a)	AUTO THROT _____ (ON)
97	CHNL 30	6	(a)	DSP INRTL DATA _____ (ON)
97	CHNL 30	7	(a)	RR CDU FAIL _____ (ON)
97	CHNL 30	8	None	N/A
97	CHNL 30	9	(a) (f)	IMU OPERATE _____ (ON)
97	CHNL 30	10	(a)	G&N CNTL LEM _____ (ON)
97	CHNL 30	11	(a)	IMU CAGE _____ (ON)
97	CHNL 30	12	(a)	ISS CDU FAIL _____ (ON)
97	CHNL 30	13	(a)	ISS FAIL _____ (ON)
97	CHNL 30	14	(a)	ISS TURNON RQST _____ (ON)
97	CHNL 30	15	(a)	TEMP IN LIM _____ (ON)
98	CHNL 31	1	(a)	+EL LPD, +PMI _____ (ON)
98	CHNL 31	2	(a)	-EL LPD, -PMI _____ (ON)
98	CHNL 31	3	(a)	+YMI _____ (ON)
98	CHNL 31	4	(a)	-YMI _____ (ON)
98	CHNL 31	5	(a)	+AZ LPD, +RMI _____ (ON)
98	CHNL 31	6	(a)	-AZ LPD, -RMI _____ (ON)
98	CHNL 31	7	(a)	+X TRANS _____ (ON)
98	CHNL 31	8	(a)	-X TRANS _____ (ON)
98	CHNL 31	9	(a)	+Y TRANS _____ (ON)
98	CHNL 31	10	(a)	-Y TRANS _____ (ON)
98	CHNL 31	11	(a)	+Z TRANS _____ (ON)
98	CHNL 31	12	(a)	-Z TRANS _____ (ON)
98	CHNL 31	13	(a)	ATTITUDE HOLD _____ (ON)
98	CHNL 31	14	(a)	AUTO STAB _____ (ON)
98	CHNL 31	15	(a)	ATT CNTR DETENT _____ (ON)

TABLE 624B-1 (CONTINUED)

WORD NUMBER	WORD NAME	BIT (S)	DATA MANIPULATION See Note ()	DISPLAY
99	CHNL 32	1	(a)	JETS 2-4 FAIL _____ (ON)
99	CHNL 32	2	(a)	JETS 5-8 FAIL _____ (ON)
99	CHNL 32	3	(a)	JETS 1-3 FAIL _____ (ON)
99	CHNL 32	4	(a)	JETS 6-7 FAIL _____ (ON)
99	CHNL 32	5	(a)	JETS 14-16 FAIL _____ (ON)
99	CHNL 32	6	(a)	JETS 13-15 FAIL _____ (ON)
99	CHNL 32	7	(a)	JETS 9-12 FAIL _____ (ON)
99	CHNL 32	8	(a)	JETS 10-11 FAIL _____ (ON)
99	CHNL 32	9	(a)	PITCH GIM OFF _____ (ON)
99	CHNL 32	10	(a)	ROLL GIM OFF _____ (ON)
99	CHNL 32	11-15	None	N/A
100	CHNL 33	1	None	N/A
100	CHNL 33	2	(a)	RR ON/AUTO _____ (ON)
100	CHNL 33	3	(a)	RR RANGE LO-SC _____ (ON)
100	CHNL 33	4	(a)	RR DATA GOOD _____ (ON)
100	CHNL 33	5	(a)	LR ALT D GOOD _____ (ON)
100	CHNL 33	6	(a)	LR POS 1 _____ (ON)
100	CHNL 33	7	(a)	LR POS 2 _____ (ON)
100	CHNL 33	8	(a)	LR VEL D GOOD _____ (ON)
100	CHNL 33	9	(a)	LR ALT LO-SC _____ (ON)
100	CHNL 33	10	(a)	BLOCK UPLINK _____ (ON)
100	CHNL 33	11	(a)	UPLINK TOO FAST _____ (ON)
100	CHNL 33	12	N/A	N/A
100	CHNL 33	13	(a)	PIPA FAIL _____ (ON)
100	CHNL 33	14	(a)	LGC WARNING _____ (ON)
100	CHNL 33	15	(a)	OSC ALARM _____ (ON)

TABLE 624B-1 (Continued)

NOTES:

N/A	Not Applicable
CTDEC	Convert the word to decimal considering the word to be a 14 bit number with a sign bit in bit 15 and that if the sign is negative (bit 15 = 1) the 14 data bits are received as the 2's complement.
CTOCT	Convert the 15 bit number to OCTAL
SF	After converting the number to decimal, multiply by the scale factor indicated.
(a)	If the bit indicated equals one, display the word underlined. If the bit indicated equals zero, display the word in parentheses.
(c)	Combine the 14 magnitude bits of the most significant (MS) part with 14 magnitude bits of the least significant part (LS). The decimal conversion should be made only after the two parts of the double precision word have been sign checked. The signs appear in bit 15 of each word. See "Remarks" for a method for handling double precision words.
(e)	NOTE: This double precision word must be scaled two ways, each of which is displayed.
(f)	Store bit status for G&N 631.
(g)	Store values for G&N 602
(h)	Store bit status for G&N 622 and 632. If the indicated bit is a one, set the SGS Discrete for VERB-NOUN FLASH. If the bit is zero, clear the discrete.
(i)	If the bit indicated equals one, set the SGS Discrete that displays the word in the display column. If the bit equals zero, remove the appropriate SGS Discrete.
(j)	These bits must also be displayed as follows: ISS MODE $\underline{X_8}\ \underline{X_6}\ \underline{X_5}\ \underline{X_4}\ \underline{X_2}\ \underline{X_1}$ where X_n is a '0' or '1' for the bit indicated by the subscript.
(k)	Treat this word as an unsigned 15 bit counter, convert to decimal and multiply by $360°/2^{15}$

Title:	LGC Downlink Interpretation Program G&N 624-200
Part Of:	Downlink Program
Purpose:	This subprogram defines the interpretation of the LGC Downlink Data which is required for ACE-S/C Console operator usage and information.
Calling Sequence:	Entry: This subprogram is activated by the LGC Downlink Format Program, G&N 621-200, whenever the format Program is processing Downlink Data. Data Input: Input from G&N 621-200 to the Downlink Interpretation Program consists of a 16-bit LGC Downlink Data Word and a word count. The position in the list identifies the data being processed. Data Output: Output will consist of CRT displays, filing and processed parameters stored in temporary buffers for use by other ACE-S/C G&N Subprograms. Normal Exit: Return to ACE Executive Program. Error Exit: None.
Computation Sequence:	Table 624-200-1 describes the contents of the list that relate to this Subprogram and provides the processing requirements for each word.
Operator Action:	None.
Uplink Requirements:	None.
Downlink Requirements:	CRT Display: The ACE-S/C Programming Requirements Documents contain the CRT scope and line information associated with displays referenced in this subprogram specification. Filing Requirements: Activation of the 'RECORD' R-START module function switch specified in the PRPS or PRD will cause the filing of a time tag and items specified for filing in Table 624-200-1.

TABLE 624-200-1

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION			DISPLAY
			Code*	Scale Factor	See Note ()	
1	ID	1-15	C20			N/A
2	ID	1-15	C20			
3	STATE VEC X POS MSB AVE-G	1-15	N/A			
4	STATE VEC X POS LSB AVG-G	1-15				
5	STATE VEC Y POS MSB AVE-G	1-15				
6	STATE VEC Y POS LSB AVE-G	1-15				
7	STATE VEC Z POS MSB AVE-G	1-15				
8	STATE VEC Z POS LSB AVE-G	1-15				
9	STATE VEC X VEL MSB AVE-G	1-15				
10	STATE VEC X VEL LSB AVE-G	1-15				
11	STATE VEC Y VEL MSB AVE-G	1-15				
12	STATE VEC Y VEL LSB AVE-G	1-15				
13	STATE VEC Z VEL MSB AVE-G	1-15				
14	STATE VEC Z VEL LSB AVE-G	1-15				
15	STATIME MSB	1-15				
16	STATIME LSB	1-15				
17						
18	DESIRED CDU X	1-15				
19	DESIRED CDU Y	1-15				
20	DESIRED CDU Z	1-15				
21	DELV X MSB	1-15				
22	DELV X LSB	1-15				
23	DELV Y MSB	1-15				
24	DELV Y LSB	1-15				
25	DELV Z MSB	1-15				
26	DELV Z LSB	1-15	N/A			N/A
27	LMPCMD	1-15	C3	1	(a)	LMP XXX
28	LMPCMD + 1	1-15	C3	1	(a)	XXX
29	LMPCMD + 2	1-15	C3	1	(a)	XXX
30	LMPCMD + 3	1-15	C3	1	(a)	XXX
31	LMPCMD + 4	1-15	C3	1	(a)	XXX
32	LMPCMD + 5	1-15	C3	1	(a)	XXX

* Refer to Table 624-200-2

TABLE 624-200-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION			DISPLAY	
			Code*	Scale Factor	See Note ()		
33	LMPCMD +6	1-15	C3	1	(a)	XXX	
34	LMPCMD +7	1-15	C3	1	(a)	XXX	
35	LMP IN	1-15	C3	1	(c)	LMP IN X	
36	LMP OUT	1-15	C3	1	(c)	LMP OUT X	
37	SPARE	1-15					
38	SPARE	1-15					
39	UPVERB	1-15	N/A				N/A
40	COMPNUMB	1-15	N/A				N/A
41	STATE COUNT	1-15	N/A				N/A
42	UPOLDMOD	1-15	N/A				N/A
43	ST BUFF +0	1-15	C6			R XXXXX	
44	STBUFF +1	1-15	C6			XXXXX	
45	ST BUFF +2	1-15	C6			XXXXX	
46	ST BUFF +3	1-15	C6			XXXXX	
47	ST BUFF +4	1-15	C6			XXXXX	
48	ST BUFF +5	1-15	C6			XXXXX	
49	ST BUFF +6	1-15	C6			V XXXXX	
50	ST BUFF +7	1-15	C6			XXXXX	
51	ST BUFF +8D	1-15	C6			XXXXX	

* Refer to Table 624-200-2

TABLE 624-200-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MUNIPULATION			DISPLAY
			Code*	Scale Factor	See Note()	
52	ST BUFF +9D	1-15	C6			XXXXX
53	ST BUFF +10D	1-15	C6			XXXXX
54	ST BUFF +11D	1-15	C6			XXXXX
55	ST BUFF +12D	1-15	C6			T XXXXX
56	ST BUFF +13D	1-15	C6			XXXXX
57	I MODES 30	1	C1, C20			IGN PIP FAIL ON ()
57	I MODES 30	2	C20			N/A
57	I MODES 30	3	C1, C20			IGNICDU FAIL ON ()
57	I MODES 30	4	C1, C20			IGNIMU FAIL ON ()
57	I MODES 30	5	C1,C26			IGNPIP FAIL ON ()
57	I MODES 30	6	C1,			INITIALIZE ISS ON ()
57	I MODES 30	7-15	C20			N/A
58	I MODES 33	1-15	N/A			N/A
59	TIME OF EVENT MSB	1-15	C4			TEVENT XXXX HR XX MIN XX.XX SEC
60	TIME OF EVENT LSB	1-15	C5,C9			
61	FC MSB	1-15	N/A			N/A
62	FC LSB	1-15	N/A			N/A
63	AOSQ	1-15	N/A			N/A

* Refer to Table 624-200-2.

TABLE 624-200-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION			DISPLAY
			Code*	Scale Factor	See Note ()	
64	AOSR	1-15	N/A			N/A
65	TIGN MSB	1-15	C4			TIGN XXXX HR XX MIN XX. XX SEC
66	TIGN LSB	1-15	C5,C9	1		
67	REDO COUNTER	1-15	C3, C20	1		REDOCTR XXXXX
68	S FAIL	1-15	N/A			N/A
69, 169						
70, 170	ACTUAL CDU X	1-15	C3, C20	$\frac{360 \text{ DEG}}{2^{15}}$		CDU ANGLE XXX.XX
71, 171	ACTUAL CDU Y	1-15	C3, C20	$\frac{360 \text{ DEG}}{2^{15}}$		XXX.XX
72, 172	ACTUAL CDU Z	1-15	C3, C20	$\frac{360 \text{ DEG}}{2^{15}}$		XXX.XX DEG
73, 173	OMEGA P	1-15	N/A			N/A
74, 174	OMEGA Q	1-15	N/A			N/A
75, 175						
76, 176	OMEGA R	1-15	N/A			N/A
77, 177	STATE	1-15	C20			N/A

* Refer to Table 624-200-2.

TABLE 624-200-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION			DISPLAY
			Code*	Scale Factor	See Note ()	
78, 178	FLAG WORD 1	1	C1, C20			AVEG ON ()
78, 178	FLAG WORD 1	2	C1, C20			GRR FLAG ON ()
78, 178	FLAG WORD 1	3	C1, C21, C20			UPLOCK ON ()
78, 178	FLAG WORD 1	4-7	C20			N/A
78, 178	FLAG WORD 1	8	C1, C20			FA INHIBIT ON ()
78, 178	FLAG WORD 1	9-12	C20			N/A
78, 178	FLAG WORD 1	13	C1, C20			TUMBFLAG ON ()
78, 178	FLAG WORD 1	14	C1, C20			TUMB MON ON ()
78, 178	FLAG WORD 1	15	C20			N/A
79, 179	FLAG WORD 2	1	C1, C20			RCS SOAK INH ON ()
79, 179	FLAG WORD 2	2	C1, C20			DPS SOAK INH ON ()
79, 179	FLAG WORD 2	3	C1, C20			RCS TEST INH ON ()
79, 179	FLAG WORD 2	4	C20			N/A
79, 179	FLAG WORD 2	5	C1, C20			TIMERS ENBL ON ()
79, 179	FLAG WORD 2	6	C1, C20			UPDAT FLAG ON ()
79, 179	FLAG WORD 2	7	C1, C20			ORB INTEG ON ()
79, 179	FLAG WORD 2	8	C1, C20			ASC FD TEST ON ()
79, 179	FLAG WORD 2	9	C1, C20			ABORT ENBL ON ()
79, 179	FLAG WORD 2	10	C1, C20			ABORT CMD R/P ON ()

* Refer to Table 624-200-2.

TABLE 624-200-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	MANIPULATION			DISPLAY
			Code*	Scale Factor	See Note ()	
79, 179	FLAG WORD 2	11	C1, C20			KALCMANU ON ()
79, 179	FLAG WORD 2	12	C1, C20			IGN FNL YAW ON ()
79, 179	FLAG WORD 2	13	C1, C20			START UPDATE ON ()
79, 179	FLAG WORD 2	14	C1, C20			NO FNL YAW RQD ON ()
79, 179	FLAG WORD 2	15	C1, C20			S/C NONXL FLT ON ()
80, 180	DAP BOOLS	1	C20			N/A
		2	C1,C20			GIM CTL IMP ON ()
		3-4	C20			N/A
		5	C1,C20			PFORCE CPLS ON ()
		6	C1,C20			ULLAGER ON ()
		7	C1,C20			MAX DB SLCT ON ()
		8	C1,C20			APS BURN ON ()
		9-10	C20			N/A
		11	C1,C20			DAP ENABLED ON ()
		12-13	C20			N/A
		14	C1,C20			RATE HOLD ON ()
80, 180	DAP BOOLS	15	C20			N/A
81, 181	CHANNEL 11	1	C20			N/A
81, 181	CHANNEL 11	2	C22, C20			COMPUTER
81, 181	CHANNEL 11	3	C22, C20			UPLINK
81, 181	CHANNEL 11	4	C22,C1 C20			TEMP CAUTION ON ()
81, 181	CHANNEL 11	5	C1, C20			KEY RELEASE ON ()
81, 181	CHANNEL 11	6	C22, C20		(d)	N/A
81, 181	CHANNEL 11	7	C1, C22, C20			OPERATOR ERR ON ()
81, 181	CHANNEL 11	8-12	C20			N/A
81, 181	CHANNEL 11	13	C1, C20			ENGINE ON ON ()
81, 181	CHANNEL 11	14	C1, C20			ENGINE OFF ON ()

* Refer to Table 624-200-2.

TABLE 624-200-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION			DISPLAY
			Code*	Scale Factor	See Note ()	
81, 181	CHANNEL 11	15	C20			N/A
82, 182	CHANNEL 12	1	C1, C19, C20			ZERO RR CDU ON ()
82, 182	CHANNEL 12	2	C1, C19, C20			RR ER CTR ON ()
82, 182	CHANNEL 12	3	C1, C20			HORIZ VEL ON ()
82, 182	CHANNEL 12	4	C1, C19, C20			COARSE ALIGN ON ()
82, 182	CHANNEL 12	5	C1, C19, C20			ZERO ICDU ON ()
82, 182	CHANNEL 12	6	C1, C19, C20			ISS ERR CTR ON ()
82, 182	CHANNEL 12	7	C20			N/A
82, 182	CHANNEL 12	8	C1, C19, C20			CDU CONTROL ON ()
82, 182	CHANNEL 12	9	C1, C20			+PITCH TRIM ON ()
82, 182	CHANNEL 12	10	C1, C20			-PITCH TRIM ON ()
82, 182	CHANNEL 12	11	C1, C20			+ROLL TRIM ON ()
82, 182	CHANNEL 12	12	C1, C20			-ROLL TRIM ON ()
82, 182	CHANNEL 12	13	C1, C20			LR POS2 CMD ON ()
82, 182	CHANNEL 12	14	C1, C20			RR LOCKON ABLE ON ()
82, 182	CHANNEL 12	15	C1, C20			ISS TRNON COMP ON ()

* Refer to Table 624-200-2

TABLE 624-200-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION			DISPLAY
			Code*	Scale Factor	See Note ()	
83, 183	CHANNEL 13	1-4	C20			N/A
83, 183	CHANNEL 13	5	C1, C20			INHIB UPLINK ON ()
83, 183	CHANNEL 13	6-9	C20			N/A
83, 183	CHANNEL 13	10	C1, C20			TEST ALARMS ON ()
83, 183	CHANNEL 13	11	C1, C20			ABL LGC STBY ON ()
83, 183	CHANNEL 13	12-15	C20			N/A
84, 184	CHANNEL 14	1	C20			N/A
84, 184	CHANNEL 14	2	C1, C20			ALT RATE SEL ON ()
84, 184	CHANNEL 14	3	C1, C20			ALT METER ACT ON ()
84, 184	CHANNEL 14	4	C1, C20			THRUST DRV ON ()
84, 184	CHANNEL 14	5-15	C20			N/A
85, 185	CHANNEL 30	1	C2, C20			ABORT ——(ON)
85, 185	CHANNEL 30	2	C2, C20			STAGE VERIF ——(ON)
85, 185	CHANNEL 30	3	C2, C20			ENGINE ARMED——(ON)
85, 185	CHANNEL 30	4	C2, C20			ABORT STAGE——(ON)
85, 185	CHANNEL 30	5	C2, C20			AUTO THROT——(ON)
85, 185	CHANNEL 30	6	C2, C20			DSP INRTL DATA——(ON)
85, 185	CHANNEL 30	7	C2, C20			RR CDU FAIL——(ON)

* Refer to Table 624-200-2.

TABLE 624-200-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION			DISPLAY
			Code*	Scale Factor	See Note ()	
85, 185	CHANNEL 30	8	C20			N/A
85, 185	CHANNEL 30	9	C2, C23, C20			IMU OPER-——(ON)
85, 185	CHANNEL 30	10	C2, C20			PGNCS CONT LM-——(ON)
85, 185	CHANNEL 30	11	C2, C20			IMU CAGE-——(ON)
85, 185	CHANNEL 30	12	C20, C2			ISS CDU FAIL-——(ON)
85, 185	CHANNEL 30	13	C2, C20			IMU FAIL-——(ON)
85, 185	CHANNEL 30	14	C2, C20			ISS TRNON RQST-——(ON)
85, 185	CHANNEL 30	15	C2, C20			TEMP IN LIM-——(ON)
86, 186	CHANNEL 31	1	C2, C20			+ELLPD/+PMI-——(ON)
86, 186	CHANNEL 31	2	C2, C20			-ELLPD/-PMI-——(ON)
86, 186	CHANNEL 31	3	C2, C20			+YMI-——(ON)
86, 186	CHANNEL 31	4	C2, C20			-YMI-——(ON)
86, 186	CHANNEL 31	5	C2, C20			+AZLPD/+RMI-——(ON)
86, 186	CHANNEL 31	6	C2, C20			-AZLPD/-RMI-——(ON)
86, 186	CHANNEL 31	7	C2, C20			+X TRANS-——(ON)
86, 186	CHANNEL 31	8	C2, C20			-X TRANS-——(ON)
86, 186	CHANNEL 31	9	C2, C20			+Y TRANS-——(ON)
86, 186	CHANNEL 31	10	C2, C20			-Y TRANS-——(ON)
86, 186	CHANNEL 31	11	C2, C20			+Z TRANS-——(ON)
86, 186	CHANNEL 31	12	C2, C20			-Z TRANS-——(ON)
86, 186	CHANNEL 31	13	C2, C20			ATTITUDE HOLD-——(ON)
86, 186	CHANNEL 31	14	C2, C20			AUTO STAB-——(ON)

*Refer to Table 624-200-2

TABLE 624-200-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION			DISPLAY
			Code*	Scale Factor	See Note ()	
86, 186	CHANNEL 31	15	C2, C20			ATT CONT DET-——-(ON)
87, 187	CHANNEL 32	1	C2, C20			JETS 2-4 FAIL-——(ON)
87, 187	CHANNEL 32	2	C2, C20			JETS 5-8 FAIL-——-(ON)
87, 187	CHANNEL 32	3	C2, C20			JETS 1-3 FAIL-——(ON)
87, 187	CHANNEL 32	4	C2, C20			JETS 6-7 FAIL-——-(ON)
87, 187	CHANNEL 32	5	C2, C20			JETS 14-16 FL-——(ON)
87, 187	CHANNEL 32	6	C2, C20			JETS 13-15 FL-——-(ON)
87, 187	CHANNEL 32	7	C2, C20			JETS 9-12 FL-——(ON)
87, 187	CHANNEL 32	8	C2, C20			JETS 10-11 FL-——-(ON)
87, 187	CHANNEL 32	9	C2, C20			GIMB OFF—(ON)
87, 187	CHANNEL 32	10	C2, C20			APP GIMB FAIL——(ON)
87, 187	CHANNEL 32	11-15	C20			N/A
88, 188	CHANNEL 33	1	C20			N/A
		2	C2, C20			RR ON/AUTO——(ON)
88, 188	CHANNEL 33	3	C2, C20			RR RANGE LO-SC—(ON)
88, 188	CHANNEL 33	4	C2, C20			RR DATA GOOD——-(ON)
88, 188	CHANNEL 33	5	C2, C20			LR ALT D OK-——-(ON)
88, 188	CHANNEL 33	6	C2, C20			LR POS 1 -——(ON)
88, 188	CHANNEL 33	7	C2, C20			LR POS 2-——-(ON)
88, 188	CHANNEL 33	8	C2, C20			LR VEL D OK ——-(ON)
88, 188	CHANNEL 33	9	C2, C20			LR ALT LO-SC-——-(ON)
88, 188	CHANNEL 33	10	C2, C20			BLOCK UPLINK-——-(ON)
88, 188	CHANNEL 33	11	C2, C20			UPLINK FAST-——(ON)

* Refer to Table 624-200-2.

TABLE 624-200-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION			DISPLAY
			Code*	Scale Factor	See Note ()	
88, 188	CHANNEL 33	12	C20			N/A
88, 188	CHANNEL 33	13	C2, C20			PIPA FAIL——(ON)
88, 188	CHANNEL 33	14	C2, C20			LGC WARNING——(ON)
88, 188	CHANNEL 33	15	C2, C20			OSC ALARM——(ON)
89, 189	DSPTAB +0	1-15	N/A			N/A
90, 190	DSPTAB +1	1-15	N/A			N/A
91, 191	DSPTAB +2	1-15	N/A			N/A
92, 192	DSPTAB +3	1-15	N/A			N/A
93, 193	DSPTAB +4	1-15	N/A			N/A
94, 194	DSPTAB +5	1-15	N/A			N/A
95, 195	DSPTAB +6	1-15	N/A			N/A
96, 196	DSPTAB +7	1-15	N/A			N/A
97, 197	DSPTAB +8D	1-15	N/A			N/A
98, 198	DSPTAB +9D	1-15	N/A			N/A
99, 199	DSPTAB +10D	1-15	N/A			N/A
100, 200	DSPTAB +11D	1-3	C20			N/A
100, 200	DSPTAB +11D	4	C1, C20			NO ATTITUDE ON ()
100, 200	DSPTAB +11D	5	C20			N/A
100, 200	DSPTAB +11D	6	C1, C24 C20			GIMBAL LOCK ON ()
100, 200	DSPTAB +11D	7	C20			N/A
100, 200	DSPTAB +11D	8	C1, C20			TRACKER FAIL——ON ()
100, 200	DSPTAB +11D	9	C1, C20			PROGRAM ALM——ON ()
100, 200	DSPTAB +11D	10-15	C20			N/A
101	TIME 2 (MSB)	1-15	C4			LGC TIME XXXX HR XX MIN XX.XXSEC
102	TIME 1 (LSB)	1-15	C5, C9 C17, C20	1		

* Refer to Table 624-200-2.

TABLE 624-200-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION			DISPLAY
			Code*	Scale Factor	See Note ()	
103	COMPTORK	1-15	C4,			COMPTORK ±XXXXX
104	COMPTORK +1	1-15	C18,C5	$1/2^7$		
105	COMPTORK +2	1-15	C4,			±XXXXX
106	COMPTORK +3	1-15	C18,C5	$1/2^7$		
107	COMPTORK +4	1-15	C4,			±XXXXXGPLS
108	COMPTORK +5	1-15	C18,C5	$1/2^7$		
109	FAILREG	1-15	N/A			N/A
110	FAIL REG +1	1-15	N/A			N/A
111	FAILREG +2	1-15	N/A			N/A
112	ALMCADR	1-15	N/A			N/A
113	ALMCADR +1	1-15	N/A			N/A
114	ERCOUNT	1-15	N/A			N/A
115	PIPA X	1-15	C7			PIPA CTR ±XXXXX
116	PIPA Y	1-15	C7			±XXXXX
117	PIPA Z	1-15	C7			±XXXXX
118						
119	STATE +4	1-4	C20			N/A
119	STATE +4	5	C1, C20			IGN DELAY ON ()
119	STATE +4	6	C1, C20			RCO NOT CNTRLD ON ()
119	STATE +4	7	C1, C20			EXT TRGT SETUP ON ()
119	STATE +4	8	C1, C20			LAMB TRGT ON ()
119	STATE +4	9	C1, C20			TGO EST ON ()
119	STATE +4	10	C20			N/A
119	STATE +4	11	C1, C20			TRF ANG GT 180 ON ()
119	STATE +4	12	C1, C20			GUESS AVAIL ON ()
119	STATE +4	13	C1, C20			1st LAMB I ON ()
119	STATE +4	14	C1, C20			LAMB COMP ON ()
119	STATE +4	15	C1, C20			LAMB RTN NCON ON ()
120						

* Refer to Table 624-200-2.

TABLE 624-200-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION			DISPLAY
			Code*	Scale Factor	See Note ()	
121	SPARE	1-15				
122	SPARE	1-15				
123	SPARE	1-15				
124	SPARE	1-15				
125	SPARE	1-15				
126	SPARE	1-15				
127	LMPCMD	1-15	C3	1	(a)	LMP XXX
128	LMPCMD +1	1-15	C3	1	(a)	XXX
129	LMPCMD +2	1-15	C3	1	(a)	XXX
130	LMPCMD +3	1-15	C3	1	(a)	XXX
131	LMPCMD +4	1-15	C3	1	(a)	XXX
132	LMPCMD +5	1-15	C3	1	(a)	XXX
133	LMPCMD +6	1-15	C3	1	(a)	XXX
134	LMPCMD +7	1-15	C3	1	(a)	XXX
135	LMPIN	1-15	C3	1	(c)	LMP IN X
136	LMPOUT	1-15	C3	1	(c)	LMP OUT X
137	SPARE	1-15				
138	SPARE	1-15				
139	MISSION PHASE REG 4	1-15	C3	1	(b)	MPHASE XX
140	MISSION PHASE REG 3	1-15	C3	1	(b)	XX
141	MISSION PHASE REG 2	1-15	C3	1	(b)	XX
142	MISSION PHASE REG 1	1-15	C3	1	(b)	XX
143	MISSION TIME REG 4	1-15	C3	1		MPTIME XXXXX
144	MISSION TIME REG 3	1-15	C3	1		XXXXX
145	MISSION TIME REG 2	1-15	C3	1		XXXXX
146	MISSION TIME REG 1	1-15	C3	1		XXXXX SEC
147	PHASE NUM	1-15	C3	1	(b)	PHASE NUM XX
148	1/PIPADT	1-15	N/A			N/A
149	TIME TO GO MSB	1-15	C4			TTGO XXXX HR XX MIN XX.XX SEC
150	TIME TO GO LSB	1-15	C5,C9	1		
151	BURN DATA	1-15	N/A			N/A

* Refer to Table 624-200-2.

TABLE 624-200-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION			DISPLAY
			Code*	Scale Factor	See Note ()	
152	BURN DATA	1-15	N/A			N/A
153	BURN DATA	1-15	N/A			N/A
154	BURN DATA	1-15	N/A			N/A
155	BURN DATA	1-15	N/A			N/A
156	BURN DATA	1-15	N/A			N/A
157	BURN DATA	1-15	N/A			N/A
158	BURN DATA	1-15	N/A			N/A
160	BURN DATA	1-15	N/A			N/A
161	BURN DATA	1-15	N/A			N/A
162	BURN DATA	1-15	N/A			N/A
163	BURN DATA	1-15	N/A			N/A
164	BURN DATA	1-15	N/A			N/A
165	BURN DATA	1-15	N/A			N/A
166	BURN DATA	1-15	N/A			N/A
167	BURN DATA	1-15	N/A			N/A
168	BURN DATA	1-15	N/A			N/A

* Refer to Table 624-200-2.

TABLE 624-200-2

GENERAL NAME	SUGGESTED CODE	DESCRIPTION
EVENTS	C1	Any of the 15 bits can be used to represent an event, with 1 = ON, 0 = BLANK.
REVERSE EVENTS	C2	Same as above, with 0 = ON, 1 = BLANK.
SINGLE PRECISION	C3	The 15-bits are converted to decimal and multiplied by a scale factor.
STORE MSB's	C4	The current 15 bits are stored to be combined with next set of 15 bits.
DOUBLE PRECISION	C5	Two consecutive words are combined into a double precision word, converted to decimal, and multiplied by a scale factor.
OCTAL CONVERSION	C6	A 15-bit word is converted to a 5 digit octal number.
DECIMAL CONVERSION	C7	A 14-bit number, with sign (15 bits) is converted to a decimal number.
G/N TIME	C9	A double precision word is converted to hours, minutes and seconds, XXXX HR XX MIN XX.XX SEC. The value of the LSB is 10 milliseconds.
WORD 78 and 178	C21	Bit 3 is saved for G/N 631, then the word processed as a regular event word.
WORD 100 and 200	C24	Bit 6 is saved for G/N 631, then the word processed as a regular event.
WORD 81 and 181	C22	Bit 6 is saved for G/N 632 and 622. Bit 2 is checked, if "1" then word "COMPUTER" is output, if "0" then blanks are output. Bit 3 is checked, and handled same as bit 2, with "UPLINK" replacing "COMPUTER". Bit 6 is also used to "blink" the VERB-NOUN display if "1", or to remove blink code if "0". Bit 7 is saved for G/N 631. The word is then processed as a regular event.

TABLE 624-200-2 (Continued)

GENERAL NAME	SUGGESTED CODE	DESCRIPTION
WORD 85 and 185	C23	Bit 9 is saved for G/N 631, then processed as a regular event.
WORD 101 and 102	C17	Store values for G&N 602.
WORD 103-108	C18	If the decimal number is greater than or equal to ±99999, display ±99999. If it is less than 99999, display the number.
WORD 82 and 182	C19	These bits must also be displayed as follows: ISS MODE X_8 X_6 X_5 X_4 X_2 X_1 where X_n is a "0" or "1" for the bit indicated by the subscript.
FILE CODE	C20	File with time tag.

Notes:

a. The resulting decimal numbers will not exceed 3 digits for words 27 thru 34 and 127 thru 134.

b. The resulting decimal numbers will not exceed 2 digits for words 139 thru 142 and word 147.

c. The resulting decimal numbers will not exceed 1 digit for words 35, 36, 135, and 136.

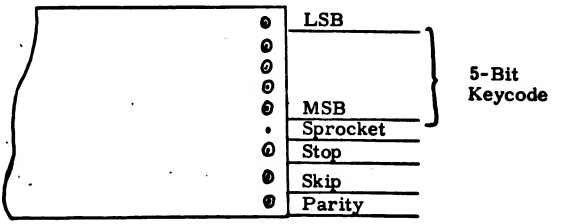
d. Flash verb numbers and noun numbers.

Title:	K-START Module Program G&N 631
Part Of:	Uplink Program
Purpose:	This subprogram accepts data input in the form of GC keycodes from the punched tape reader or the keyboard, via the K-START module. These keycodes are checked for correct parity and valid codes and then formatted into a command word for eventual transmission to the External DTCS. The status of the Uplink system and the GC is monitored, and the Uplink command sequence is controlled, to the acceptable input rate of the GC.
Calling Sequence:	Entry: This subprogram operates under Uplink Executive Program control and will be initiated from K-START module. Normal Exit: Return to Uplink Executive Program Error Exit: Error conditions will be displayed for the operator on the CRT and recorded on the Command Tape. Those error conditions are subsequently described in Table 631-1.
Data Inputs:	1) The data content utilized by this subprogram consists of a five bit Keycode plus a parity level. The input consists of information received either from K-Start punched tape (Automatic Mode) or from the K-Start Keyboard (Manual Mode). 2) Keycode delay factor of XXX milliseconds entered via C-Start. The format for this input is specified in the PRPS on PRD.

Computation Sequence:

This subprogram is initialized upon operator action by means of the K-START module, either in manual or automatic modes. A five bit keycode (see Table 631-2) as previously mentioned is generated by internal logic upon depression of a keyboard switch or by punched tape input via the tape reader. A transfer to G&N 632 takes place if an R-START module execute is detected.

The format of the paper tape entry is shown below.



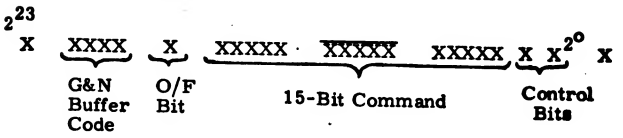
During keyboard entry, the stop and skip positions will contain zeroes and the parity bit is generated internally upon depression of the keyboard switch.

Once a keycode is received by G&N 631, no other data is allowed into this subroutine until so commanded, to ensure that the GC receives Uplink commands at the correct transmission frequency. The keycode is checked with the parity bit to assure that odd parity exists. In the event of a parity error, a CRT display occurs, combined with the "non-verify" lamp display to inhibit further entry through the K-START module. A normal Command Tape recording occurs for post test analysis. If parity is odd, a check is made on the validity of the received keycode, by means of table look-up. A CRT display occurs with a "non-verify" light to indicate an invalid keycode and to inhibit further commands. A normal Command Tape recording occurs for post test analysis.

A valid keycode is then transformed into a 16-bit GC Uplink Word format and combined with the DTCS G&N buffer address

and required control bits as shown below.

G&N UPLINK WORD FORMAT



Prior to transmittal of a sequence of command words, a sequence of tests are made on the incoming keycodes to determine if the command sequence contains a V36. If so, two GC discretes are monitored, namely the "Gimbal Lock" and the "IMU Operate". If both discretes are set to a "one" state, then a "non-verify" display will occur on the K-START and the next keycode will not be transmitted Uplink. Another discrete is monitored, the "Operator Error" flashing discrete (Channel 11, bit 7). An error status will cause this subprogram to terminate the processing of GC commands by inhibiting further K-START data entry with a "non-verify" signal. A normal system recording will occur on the command tape as specified in Table 631-1.

The final discrete tested is GC word UPLOCK, bit 1. A "one" state will result in a test for an "alarm reset" keycode. If this code is available, then two commands will be transmitted at the correct frequency. The first command will zero the GC Uplink register and the second, namely, the "reset" keycode will possibly reset the alarm indication triggered by UPLOCK, bit 1. The "zero" state for this discrete, will allow the subprogram to continue and transmit the commands to the GC with subsequent recordings on the command tape.

The K-START module is sealed after receipt of a keycode, to allow the correct transmission frequency to the GC to be utilized. The sealing can occur as soon as a "good" CSR is received from the DTCS, after which a time delay is utilized to give an approximate maximum input rate to the GC of six keycodes/sec.

A "bad" CSR response should cause the K-START to display a "non-verify" and subsequently be unsealed, to allow further

operator action to be taken. It should be noted at this point, that as the state of the above mentioned discretes can change at a maximum of only once every second, approximately eight commands could be transmitted Uplink before repeating discrete testing. Figure 631-1 is given as a representative flow, to convey the intent of the subprogram operation.

Operator Action:

During the processing of the input keycodes a test is made to determine whether the range time since "Sealing" the K-START module is greater than or equal to the time delay factor entered via C-START. . If so, the verify indication is displayed and the subprogram then transfers control to the Uplink Executive program. If not, the module remains "Sealed" to inhibit further input through the K-START module until the time delay has elapsed. This regulates the input rate of keycodes to the GC. A nominal time delay factor is 90 milliseconds.

Console Operator: Operator action is required to initiate this sub-program by entering data via the K-START module keyboard or tape reader.

When a NON-VERIFY display occurs, further character entry is allowed after depression of the NON-VERIFY switch.

For tape mode of operation enter 3100000XXX into C-START. XXX is the time delay factor in milliseconds.

The operator's responsibility includes the monitoring of displays and the initiation of procedures based upon the display interpretation. Normally the status of the "Accept Uplink" discrete was processed by the K-START module subprogram (G&N 631) prior to transmission of data Uplink. However, this discrete is now permanently wired to give a display of "Accept Uplink On", therefore no testing of this bit by this subprogram (G&N 631) takes place. If the "Operator Error On" condition appears, this subprogram will inhibit data transfer through the K-START with a non-verify. The operator will reset this "non-verify" switch and insert a "reset" keycode to clear the "Operator Error" display. Then correct the illegal data sequence and re-enter through the K-START.

An "UPLOCK bit '" display will again inhibit data transfer through the K-START. The operator will reset the "non-verify" and insert a "reset" keycode to clear the discrete. The subprogram will then transmit a "zero" message followed by the "reset" keycode. This may reset the "UPLOCK" discrete and the operator can continue his interrupted sequence of commands by re-inserting the previous keycode.

Two other conditions cause this subprogram to inhibit data input through the K-START, they are a parity error and an invalid keycode. The operator will release the non-verify and apply corrective measures to the input.

If a "Keyerr 2" CRT display occurs, then the operator should re-insert the "Verb 36 Enter" sequence after monitoring the "Gimbal Lock" and "IMU Operate" discrete displays.

Commands inserted via the keyboard will be verified by means of the "closed loop" display, which depicts the GC DSKY status on the CRT, prior to depression of the "Enter" keycodes. The punched tape input, if visual verification is desired, should contain strategically located "stop" codes in the Verb/Noun and parameter sequences, to allow the operator time to perform verification.

Spacecraft Operator: No activity required.

Uplink Requirements: DTCS Transmission: The data word transmitted to the G&N buffer is identified in the Computation Sequence and will be generated as required.

DTCS Stimuli: None

Transmission Time: During G&N testing this will be specified in the Operational Checkout Procedure. All other times will be as required.

Filing: 1) All K-START command information will be recorded on the command tape.

2) Additional recordings for error conditions and discrete inhibits are specified in Table 631-1.

Downlink Requirements: CRT Displays:

1. The time delay factor in XXX milliseconds and the appropriate nomenclature.

2. Program error displays as specified in Table 631-1.

The Program Requirements Process Specification contains the CRT page and line information.

Remarks: Definition of Flow Chart Symbols

Symbol	Definition
KEYWORD	Contains current keycode to be processed.
ZERCODE	Uplink command to zero the LGC Inlink register for resync purposes.
UPCOM	Contains command word content.
Channel 30 Channel 11 UPLOCK DSPTAB +11	GC Discrete registers, processed by G&N 624A, 624B, or 224A.

Table 631-1

CRT Error Display Definition

Error or Discrete	CRT Display	K-START Module Display	Command Tape Edit
Odd parity does not exist in the data frame received from K-START module.	PARERR 1	Non-Verify	631, PARERR 1, Time Ref.
An invalid GC keycode has been received by this sub-program.	KEYERR 1	Non-Verify	631, KEYERR 1, Time Ref.
An illegal entry of a V36E has occured.	KEYERR 2	Non-Verify	631, KEYERR 2, Time Ref.
This indicates that an incorrect keycode loading procedure has occured and entry through the K-START is inhibited.	OPERATOR ERROR ON*	Non-Verify	631, Op. Error, Time Ref.

*These CRT discrete displays are set by G&N 624A or 624B ACE-S/C Downlink Interpretation Program.

Table 631-2

Legal AGC/LGC Keycodes

Character	Code MSB LSB
0	10000
1	00001
2	00010
3	00011
4	00100
5	00101
6	00110
7	00111
8	01000
9	01001
VERB	10001
RESET	10010
KEY RELEASE	11001
PLUS	11010
MINUS	11011
ENTER	11100
CLEAR	11110
NOUN	11111

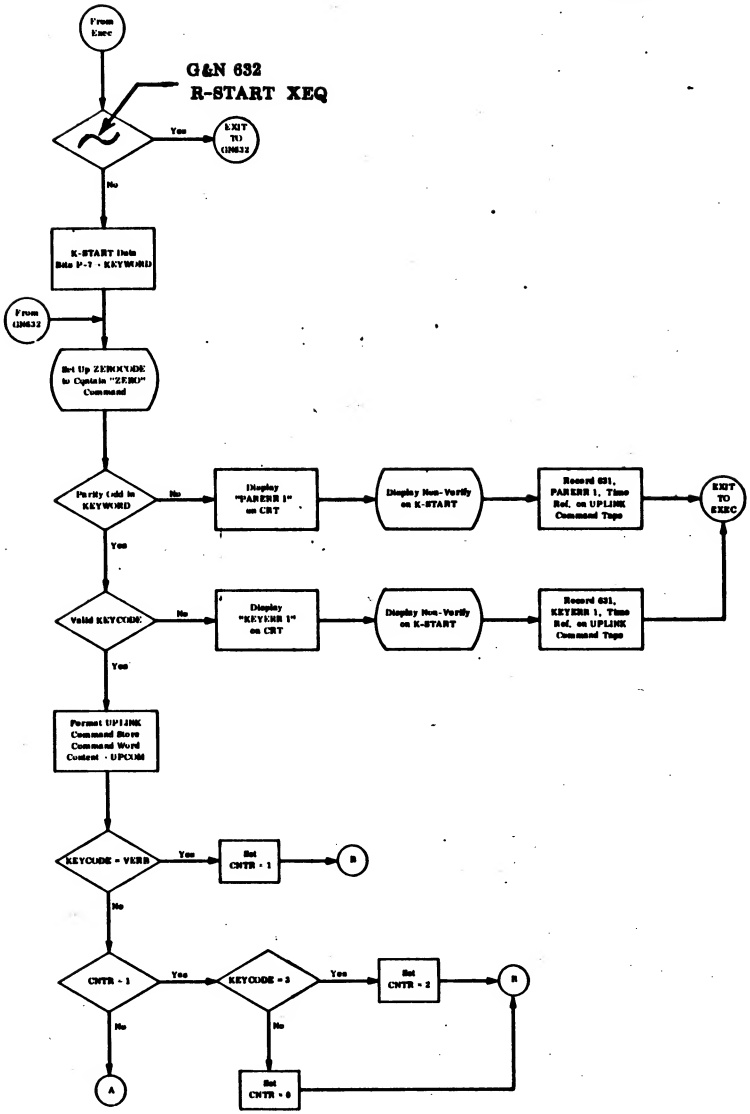


Figure 631-1 (1 of 3)

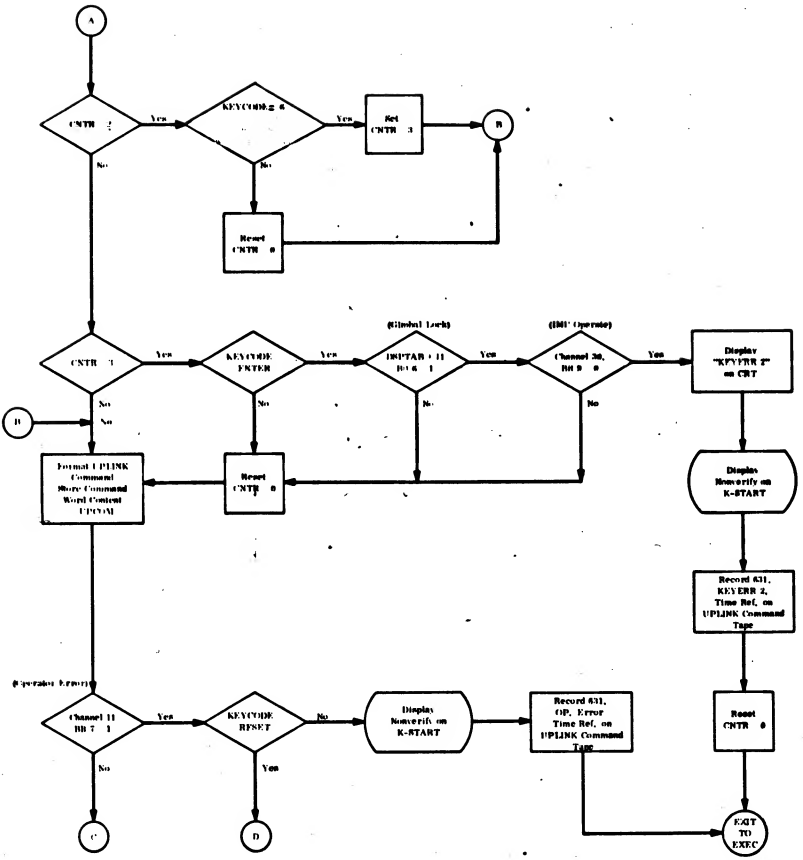


Figure 631-1 (2 of 3)

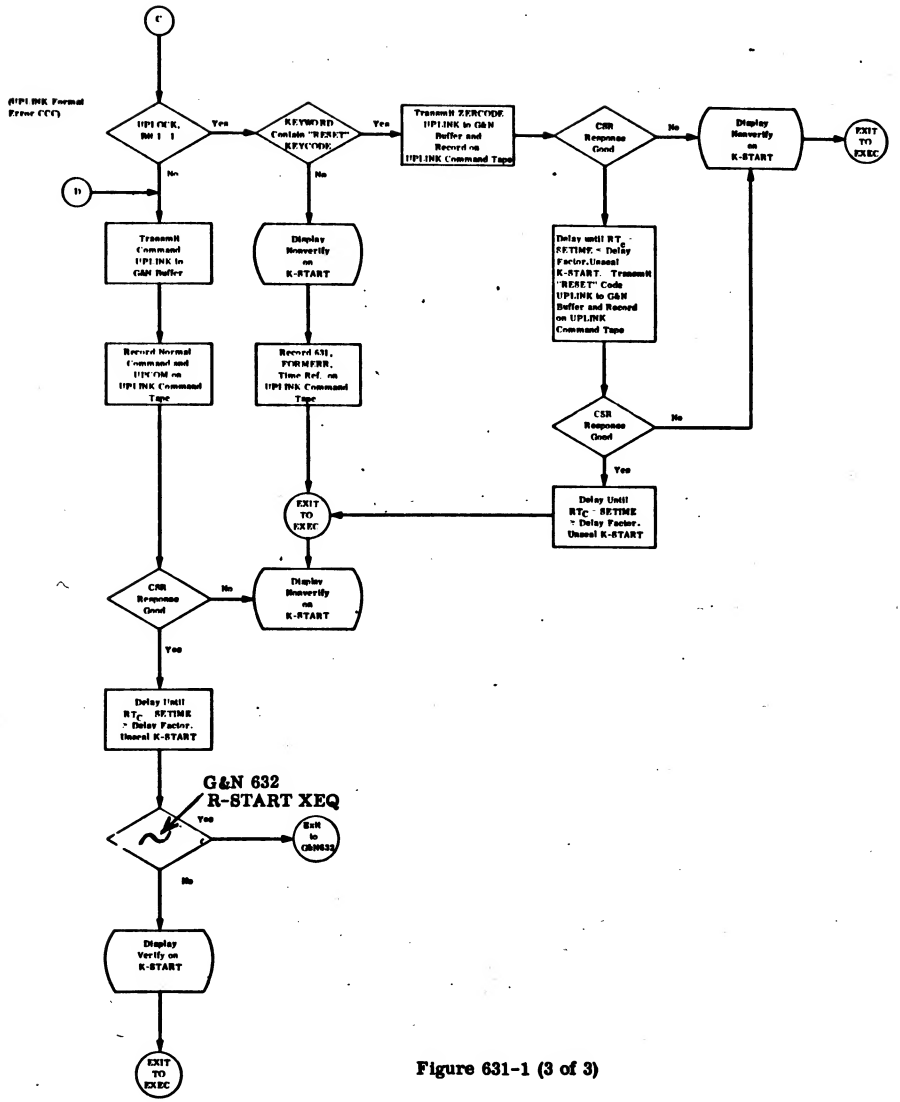


Figure 631-1 (3 of 3)

Title: Special K-Start Load-Verify and Verify Program G&N 632

Part Of: Uplink Program

Purpose: This program is used to check and verify or record the contents of GC erasable memory locations. All data to be verified or recorded is specified on pre-punched K-Start input tapes.

Two options have been provided for verification or recording. Selection of these options is attained through activation of R-Start Module function switches and K-Start.

Calling Sequence: Entry: This program is activated only by the K-Start Module Program (G&N 631), whenever it in turn has been activated and also if the R-Start Module specified in the PRPS or PRD has been executed. Function switches of this R-Start Module specify one of two options used by G&N 632. These are:

1. Load-Verify - Activation of the specified R-Start Module function switch causes G&N 632 to verify that the data being loaded into erasable GC memory locations is identical to the data stored on the K-Start input tape.

2. Verify - Activation of the specified R-Start Module function switch causes G&N 632 to check and verify that the contents of previously loaded and verified GC erasable memory locations have not been altered by internal GC functions or external input means.

Data: This consists of information received from punched K-Start tapes. The data content utilized by this subprogram consists of five bit keycodes plus a parity level.

Normal Exit:

1. Return to G&N 631 whenever keycodes are to be checked for validity and parity and then transmitted to the GC

2. Return to Uplink Executive Program when a complete Special K-Start tape sequence has been processed by G&N 632 and 631.

Error Exit: Error conditions will be displayed on the CRT for operation action.

Computation Sequence:

Activation of this program is attained via the K-Start Module Program, G&N 631 following operator action on the specified R-Start Module and K-Start Module. Execution of the R-Start must occur before K-Start action. The K-Start execute causes the ACE Executive to activate G&N 631 which in turn activates and maintains close interface with G&N 632 provided R-Start Module execution is sensed by G&N 631. If G&N 631 does not detect execution of this R-Start it then treats the K-Start input tape in a normal fashion. The paragraphs below represent a description of the logic contained in the flow diagram shown in Figure 632-1.

Upon entry from G&N 631 various counters and indicators are set to specific values depending on which function switch of the R-Start Module has been executed. G&N 632 then reads the R1 keycode characters into the CDC and seals the K-Start Module. These keycode characters represent the initial VERB-NOUN sequence to be transmitted Uplink.

The format of this "record" is checked for validity. This should be 18 keycode characters for the Load-Verify and Verify tape (the tape format defined in Table 632-1.) Format non-verification results in a CRT error display, K-Start Module release and program control return to ACE Executive. If the Verify option has been selected, the one component load Verb-Noun is changed to one component display Verb-Noun (V21N01 to V01N01).

At this point in the program a loop is set up, based on the value of K1, which loads one keycode at a time into KEY-WORD and allows G&N 631 to perform its normal function of completely verifying each keycode from G&N 632 and transmitting each Uplink. (See G&N 631). After all appropriate keycodes have been transmitted Uplink, the Flash discrete is obtained from the G&N 622 buffer. A test is made on the Flash discrete. If "1" (flashing), G&N 632 delays until the next DSPTAB table is displayed by G&N 622 and repeats the "Flash" test. A third failure in this area should cause an error exit with a CRT error display and a return to ACE Executive.

If the "Flash" discrete is "0" (stop flashing), the program delays until the next DSPTAB table is processed by G&N 622 and obtains the R1, R3, VERB and NOUN values. This delay is to assure G&N 632 that all pertinent GC DSPTAB updated data has been received by the Display Program. Following this delay the Verb-Noun combination for the particular tape option in progress is checked for validity, the input address is compared against the contents of R3 and the input constant is compared against the contents of R1. Any invalid test results in an error exit as specified above.

Following valid testing, G&N 632 releases the K-Start seal, reads one keycode character and checks this code for Key-release. Detection of the Key-release code will result in K-Start module seal and an exit to G&N 631 for Uplink transmission of the Key-release Keycode. When re-entered from G&N 631, the K-Start module is un-sealed, KSEQ "OK" is displayed on the CRT and G&N 632 returns control to the ACE executive. If, however, the first code of the "record" is not Key-release, G&N 632 reads R2-1 keycode characters into the CDC and seals the K-Start Module. These keycode characters represent interim "records" of keycode data necessary for the proper operation of the one parameter Load or Display Verb-Noun combination in the GC. The format of each "record" is tested for validity. An improper format results in an error exit as previously specified. With a legal "record" the program sets up a loop, based on the K2 value, for Uplink Keycode transmission via G&N 631.

Following successful Keycode transmission G&N 632 obtains pertinent data from the G&N #622 buffer and repeats a sequence of testing as specified above.

Operator Action:

Console Operator: To activate G&N 632, the R-Start Module specified in the PRPS or PRD must be executed. Two options are available:

1. One function switch selects the Load-Verify option.
2. The other selects the Verify option.

In addition to the R-Start execute, the K-Start Module must also be activated.

The operator's responsibility also includes the monitoring of displays and the initiation of procedures based upon the display interpretation. Before initiating action to process a Special K-Start tape via G&N 632, the console operator should check and perform the following operations:

1. Depress the NON-VERIFY switch if the non-verify light is on.

2. Check the CRT status of:

Operator Error discrete for "ON"

If any of these conditions exist, Uplink transmission will be inhibited by G & N 631. Recovery Procedures for these conditions are specified in the "K-Start Module Program G & N 631" Computation sequence section.

After verifying that the above conditions have been fulfilled the operator may initiate processing of the Special K-Start tape as prescribed. CRT monitoring should continue during G & N 632 K-START tape processing. Illumination of the NON-VERIFY light will result in the discontinuation of the Special K-Start tape processing. When this occurs, the console operator should record the indicated error in order to initiate corrective procedures. The error displayed will be one of the following:

1. VERROR 1 through VERROR 5 indicates error detection in G &N 632 (See Table 632-2 for definitions.)

2. PARERR 1, KEYERR 1, or Operator Error "ON" indicate error detection in G&N 631.

An error free K-Start tape sequence will result in the CRT display of KSEQ 'OK'.

VERROR Recovery Procedures

One of three operator actions must be taken if G &N 632 detects an error (VERROR type).

1. Re-cycle: This allows a re-run of the present K-Start tape sequence.

 a. Re-load K-Start tape to Verb character.

 b. Re-initiate K-Start action.

2. Continue: This allows tape operation to continue from point of error.

 a. Re-initiate K-Start action.

3. Abort: This terminates processing of the present K-Start tape sequence.

a. Manually insert 'ERROR-RESET' to allow G & N 632 to "unseal" the R-Start module.

Spacecraft Operator:

No activity required.

Uplink Requirements:

DTCS Transmission:

The word transmitted Uplink is identified in the Computation Sequence section of G & N 631.

DTCS Simuli:

None.

Transmission Time:

As required.

Filing:

All K-Start command information will be recorded on the command tape by G & N 631.

Downlink Requirements:

CRT Display:

This information is detailed in the program flow chart and consists of KSEQ 'OK' if no errors occur or program error displays if any are detected by either G & N 632 or G & N 631. If this test is aborted by means of the "ERROR-RESET" code, KSEQ 'NG' will be displayed on the CRT. Error displays are defined in Table 632-2. The ACE Requirements Specification contains the CRT scope page and line information.

Remarks: A definition of terms used in this subprogram is as follows:

1. Flag — Program indicator specifying one of three program options.
2. K1 — Counter which specifies the number of keycodes to be initially transmitted to the GC.
3. K2 — Counter which specifies the number of keycodes to be transmitted to the GC after initial transmission.
4. R1 — Counter which specifies the number of keycode characters to be initially read and processed.
5. R2 — Counter which specifies the number of keycode characters to be read and processed after the initial "record".
6. KEYWORD — Register containing 8 bit keycode for G & N 631 processing.
7. VERROR — Indicator set by G & N 632 whenever errors are encountered. (See Table 632-2.)
8. KSEQ — CRT Indicator set to display 'OK' if a complete Verb-Noun sequence is verified error free. Set to 'NG' if test is aborted due to error detection. Entry to G & N 632 blanks 'NG' or 'OK'.
9. BLKCNT — Value specifies K-Start data block being processed when G & N 632 detects an error. Part of Uplink command tape recording.
10. WDCNT — Value specifies last tape input character which was detected as an error by G & N 632. This word count is used in conjunction with the Block Count value. Part of Uplink command tape recording.

Table 632-1

TAPE FORMATS

Load-Verify and Verify Tape

HEADER
Verb 21 Noun 01 ENTER
4 octal digit address ENTER
5 octal digit constant ENTER
ENTER
4 octal digit address ENTER
5 octal digit constant ENTER
⋮
ENTER
4 octal digit address ENTER
5 octal digit constant ENTER
STOP KEYRELEASE

Table 632-2

CRT ERROR DISPLAY DEFINITION FOR G&N 632

Error	CRT Display	K-Start Module Display
Improperly formatted K-Start tape.	VERROR 1	Non-Verify
Flash discrete 'ON'. Load or display Verb-Noun address and/or data values not accepted by GC.	VERROR 2	Non-Verify
DSPTAB Verb-Noun not same as input Verb-Noun.	VERROR 3	Non-Verify
DSPTAB address (R3) does not verify with input address.	VERROR 4	Non-Verify
DSPTAB constant (R1) does not verify with input constant.	VERROR 5	Non-Verify

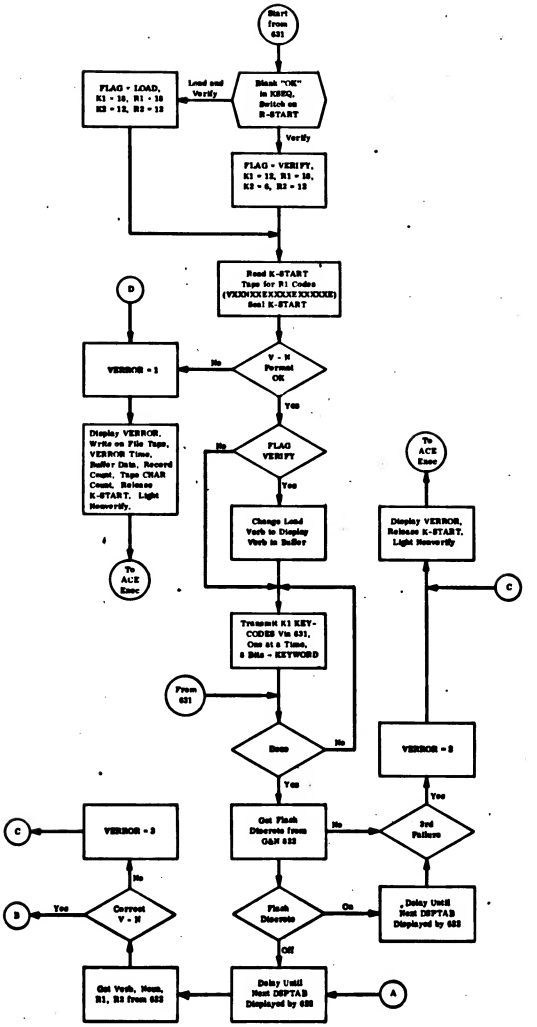


Figure 632-1 (1 of 2)

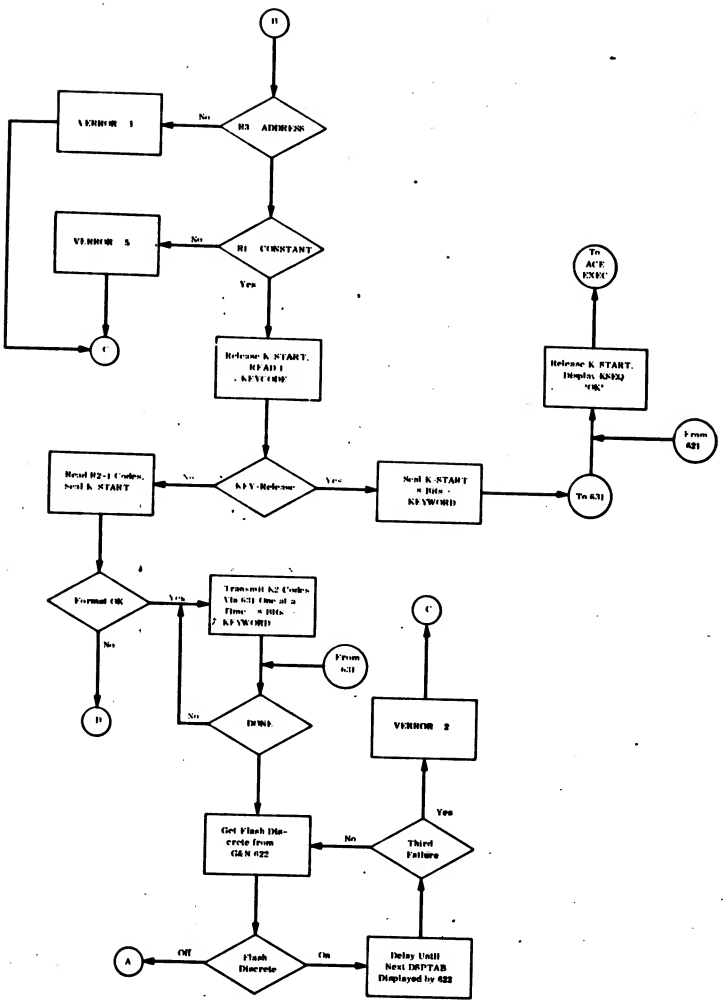


Figure 632-1 (2 of 2)

Title: G&N High Rate Channel Control Program G&N 641

Part Of: Communication Program

Purpose: This program controls the switching of selected signals for transmission over the 400 sample/second high rate sampling channel.

Calling Sequence: Entry: This program will operate under Executive Control and will be initiated from the C-START module specified in the PRPS or PRD.

Data: C-START Module data entry - Window ten (10), eight (8) and seven (7) are set to desired characters.

Normal Exit: Return to Executive Control

Error Exit: None required

Computation Sequence:

This program is entered from the Executive Program when requested by the C-START module. Selector switches eight (8) and seven (7), are utilized for high rate channel selection, while selector switch ten (10) (leftmost selector switch) will be utilized for program identification. Selector switch ten (10) will be tested, and when found to contain the digit two (2), will cause entry into the high rate channel select program. Selector switches eight (8) and seven (7) will be tested to determine which measurement, if any, is being requested. If the code contained in windows eight (8) and seven (7) exceeds the limits of the matrix (i.e. greater than 32 decimal) the program exits to Executive Control. If the code is a valid code, the program tests to determine if the code is the same as the code for the measurement presently displayed. In the event that the selection has not changed, the

signal selection command is ignored and control is returned to the Executive Program. If the code contained in windows eight (8) and seven (7) is a code for a new measurement, the program will then cause the computer to generate the commands necessary to remove the previously selected signal from the matrix and by energizing one or more of the ten high rate control relays in the DTCS, cause the new signal to be switched onto the 400 S/S channel. The relay assignments will be specified in GAEC or NAA Program Requirements Specification. Figure 641-1 is a representative flow diagram of this subprogram.

Operator Action: Console Operator action is required to initiate this program by C-START selection of the high rate signals. The sequence is as follows:

a. The desired program identification digit (2) is entered into selector switch ten (10).

b. The desired measurement identification digits are entered into selector switches eight (8) and seven (7).

c. The XEQ/SEAL Switch is depressed.

Spacecraft Operator: No activity required.

Uplink Requirements:

GC Transmission: None

Time of Transmission: Not defined

Filing Requirements: Measurement ID, time tag

Downlink Requirements:

Measurement ID: The Measurement ID and description is contained in the PRPS or PRD. NOTE: The measurement description is NOT displayed on CRT.

CRT Display: The following CRT display is required "High Rate Meas. X X X X", where X X X X refers to the NASA measurement number of the particular measurement selected. The measurement number portion of the CRT display for channels with no assigned measurements shall be "XXOOMN" where M and N are the numbers from C-START windows 8 and 7.

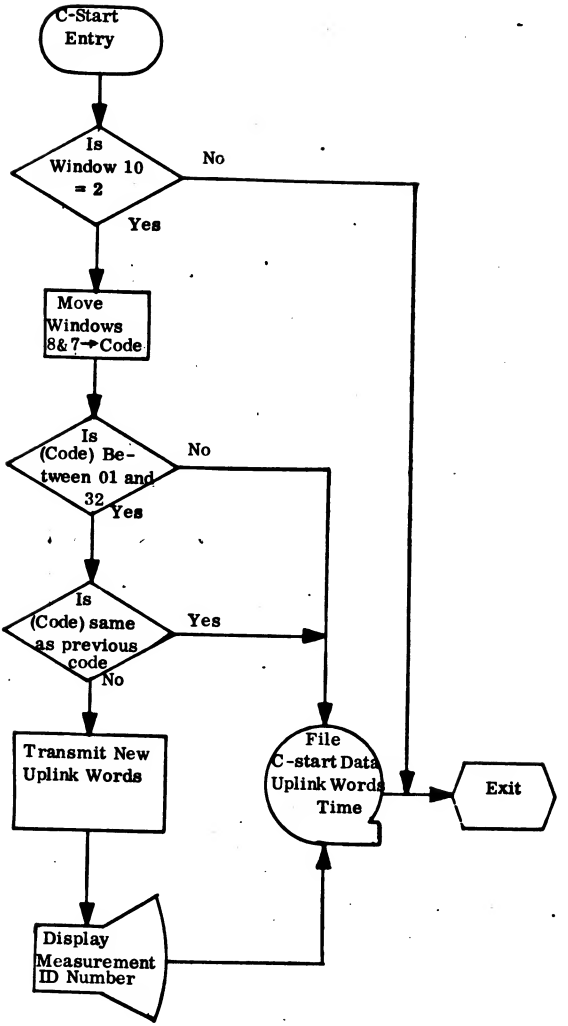
Filing Requirements: None

Remarks:

The high rate measurements are sampled 400 samples per second, spaced symmetrically in the telemetry format, by the analog gates in the PCM carry-on system. The time duration over which the measurement is recorded on the analog recorder is determined by the operator.

The required high rate channel information for any given vehicle will be defined by AC in the Programming Requirements issued in a GAEC or NAA process specification.

Providing an ACE program that will enable switching of all 32 channels will permit further expansion of the list of high rate signals without the need to reprogram the ACE computer. Suitable limit checks on the number of measurements available, perhaps supplied as a card input to the ACE program, would prohibit calling up an unused channel.



Flow Diagram

Figure 641-1

Title: Special IMU Processing G&N 652

Part Of: Communication Program

Purpose: This program converts the IMU 1X gimbal resolver sin and cos PCM values to degrees for display on the CRT. This subprogram specification is identical to the specification for G&N 152A (See 4-152A.1)

Title: ACE-S/C Error Reset Program G&N 671

Part Of: Downlink Program

Purpose: This subprogram resets the error displays on the CRT display unit to give a "no error" indication for the ACE-S/C subprograms utilized with the LEM Block II G&N System.

Calling Sequence: Entry: This subprogram operates under executive control and is initiated from the R-START Module specified in the PRPS or PRD.

Exit: Return to Downlink Executive Program after error displays are reset.

Computation Sequence: The error displays reset by this subprogram are listed below, along with the ACE-S/C subprogram that generates them during its operation. The CRT page and line location for each error display is detailed in the Program Requirements Process Specification.

Error Indication	G&N Program Number
TIME ERROR (1)	601
TIME ERROR (2, 4)	602
TIME ERROR (3)	603
SYNCERR (1, 2)	621 or 221
WORDERR (1, 2, 3, 4, 5, 6)	
RELERR (1)	622
PARERR (1)	631
KEYERR (1)	
VERROR (1, 2, 3, 4, 5)	632
FSERR (1)	681

Each error display consists of a variable segment (underlined) which signifies the type of error condition occuring in a particular ACE-S/C subprogram, and a fixed title segment. When initiated by the operator, this subprogram will blank out the variable segments of the error displays.

Operator Action: Console Operator: Operator action is required to initiate this subprogram via the R-START module.

Spacecraft Operator: No activity required.

Uplink Requirements:

The ACE-S/C Uplink system is not utilized.

Downlink Requirements:

PCM data processing is not required by this subprogram.

Title: PIPA Switching and Stabilization Loop Response Test G&N 681

Part Of: Uplink Program

Purpose: This subprogram provides step inputs to the IRIG stabilization loop, for the servo loop response test and enables display of the PIPA signal generator outputs. This subprogram specification is identical to the specification for G&N 181. (See 4-181.1).

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ACE-S/C COMPUTER SUBPROGRAM

SPECIFICATIONS FOR APOLLO

CM AND LM G & N TESTING

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Date	Revision Letter	TDRR No.	Pages Revised	APPROVALS AC	APPROVALS NASA
12/8/66	A	32263	2,3,81,115,199,200,206,209,214-345. Was 345 pages, Now 352 pages. ROC/AC	EA	WLS
12/21/66	B	32361	266, 270 ROC/AC	JP	--
1/6/67	C	32582	3,144,145,185,228-352 was 352 pages now 380 pages ROC/AC	EA	--
1/26/67	D	32756	292, 295 ROC/AC	EA	--

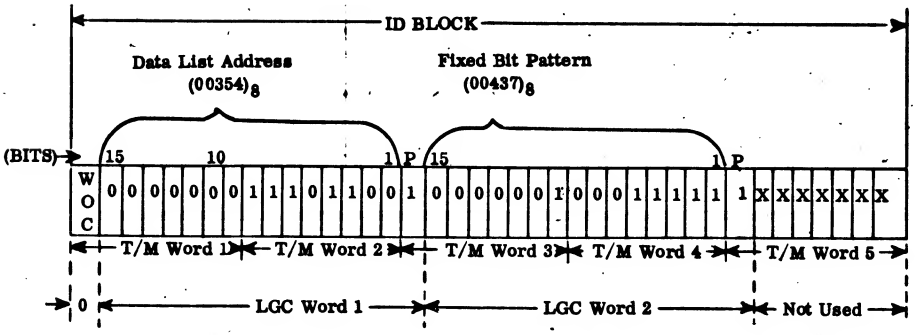
This specification consists of 380 total pages.

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WORD 4	8	7	6	5	4	3	2	1
WORD 5	P	X	X	X	X	X	X	X

Where WOC = Word order code (1-bit)
P = Parity (LGC word has odd parity)
X = Not used

The ID block should normally appear once every 100 prime frames and contains a zero WOC, two LGC 16-bit words including parity bits (P) and seven unused bit positions (X). LGC word 1 contains the data list address in bit positions 15-1 and parity (P) in bit position zero. LGC Word 2 contains a fixed bit pattern sync word $(00437)_8$ in bit positions 1-15 and Parity (P) in bit position zero. LGC Word 1 precedes LGC Word 2 in the data block transmission. The word order code (WOC) bit contains a 0 for all LGC ID blocks. An example block and word formats is shown below.



The following ID groups shall be accepted as valid:

Downlist No.	(ID Word)8	(SYNC Word)8	Table No.
1	00354	00437	621-200-1

The data blocks (normally 99 between ID blocks) contain a WOC, two LGC 16-bit words including parity bits (P) and seven unused bit positions (X).

LGC Word 1 precedes LGC Word 2 in the data block transmission. The word order code (WOC) bit contains a 1 for all LGC Data Blocks. The block and word formats are specified as follows:

621-200.2

TABLE 621-200-1

DOWNLIST NO. 1

BLOCK	WRD CNT	LGC WRD 1	WRD CNT	LGC WRD 2	WOC
1	1	DOWNLIST ID (00354-octal)	2	SYNC BITS (00437-OCTAL)	0
2	3	STATE VEC X POS MSB AVE-G	4	STATE VEC X POS LSB AVE-G	1
3	5	STATE VEC Y POS MSB AVE-G	6	STATE VEC Y POS LSB AVE-G	1
4	7	STATE VEC Z POS MSB AVE-G	8	STATE VEC Z POS LSB AVE-G	1
5	9	STATE VEC X VEL MSB AVE-G	10	STATE VEC X VEL LSB AVE-G	1
6	11	STATE VEC Y VEL MSB AVE-G	12	STATE VEC Y VEL LSB AVE-G	1
7	13	STATE VEC Z VEL MSB AVE-G	14	STATE VEC Z VEL LSB AVE-G	1
8	15	STATIME MSB	16	STATIME LSB	1
9	17	GARBAGE	18	DESIRED CDU X	1
10	19	DESIRED CDUY	20	DESIRED CDU Z	1
11	21	DELV X MSB	22	DELV X LSB	1
12	23	DELV Y MSB	24	DELV Y LSB	1
13	25	DELV Z MSB	26	DELV Z LSB	1
14	27	LMP CMD	28	LMP CMD+1	1
15	29	LMP CMD+2	30	LMP CMD+3	1
16	31	LMP CMD+4	32	LMP CMD+5	1
17	33	LMP CMD+6	34	LMP CMD+7	1
18	35	LMP IN	36	LMP OUT	1
19	37	SPARE	38	SPARE	1
20	39	UPVERB	40	COMPNUMB	1
21	41	STATE COUNT	42	UPOLDMOD	1
22	43	ST BUFF +0	44	ST BUFF +1	1
23	45	ST BUFF +2	46	ST BUFF +3	1
24	47	ST BUFF +4	48	ST BUFF +5	1
25	49	ST BUFF +6	50	ST BUFF +7	1
26	51	ST BUFF +8D	52	ST BUFF +9D	1
27	53	ST BUFF +10D	54	ST BUFF +11D	1
28	55	ST BUFF +12D	56	ST BUFF +13D	1
29	57	I MODE 30	58	I MODE 33	1
30	59	TIME OF EVENT MSB	60	TIME OF EVENT LSB	1
31	61	FC MSB	62	FC LSB	1
32	63	AOSQ	64	AOSR	1
33	65	TIGN MSB	66	TIGN LSB	1
34	67	REDO COUNTER	68	S FAIL	1
35	69	GARBAGE	70	ACTUAL CDU X	1
36	71	ACTUAL CDU Y	72	ACTUAL CDU Z	1
37	73	OMEGA P	74	OMEGA Q	1
38	75	GARBAGE	76	OMEGA R	1
39	77	STATE	78	FLAGWORD 1	1
40	79	FLAGWORD 2	80	DAP BOOLS	1
41	81	CHANNEL 11	82	CHANNEL 12	1

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ACE-S/C COMPUTER SUBPROGRAM

SPECIFICATIONS FOR APOLLO

CM AND LM G & N TESTING

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Date	Revision Letter	TIRR No.	Pages Revised	APPROVALS AC	APPROVALS NASA
12/8/66	A	32262	2, 3, 81, 115, 199, 200, 206, 208, 214-345.	EA	WLS
			Was 345 pages, Now 352 pages. ROK/mc		
12/21/66	B	32361	266, 270	JP	--
1/6/67	C	32582	3, 144, 145, 185, 229-352 was 352 pages	EA	--
			now 390 pages ROK/mc		
1/26/67	D	32756	292, 295 ROK/AC	EA	--
3/3/67	E	33114	3, 265-267, 269, 274, 280, 292,	EA	--
			310-312, 332, 336, 351, 377 and 378	ROK/mc	

This specification consists of 390 total pages inclusive.

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TABLE 2B4A-2

WORD NO.	WORD NAME	BITS	DATA MANIPULATION See Notes (-)	DISPLAY	SCALE FACTOR
3	PIPAX	1-15	CONVERT TO DECIMAL	PIPAX±XXXXX	1
4	PIPAY	1-15	CONVERT TO DECIMAL	PIPAY±XXXXX	1
5	PIPAZ	1-15	CONVERT TO DECIMAL	PIPAZ±XXXXX	1
6	BMAGY	1-15	CONVERT TO DECIMAL	BMAGY±XXXXX	1
7	BMAGX	1-15	CONVERT TO DECIMAL	BMAGX±XXXXX	1
8	BMAGZ	1-15	CONVERT TO DECIMAL	BMAGZ±XXXXX	1
23	IMODES30	1	(a)	IGN PIP FAIL ON (OFF)	N/A
23	IMODES 30	2	NONE	N/A	
23	IMODES30	3	(a)	IGN ICDU FAIL ON (OFF)	N/A
23	IMODES30	4	(a)	IGN IMU FAIL ON (OFF)	N/A
23	IMODES30	5	NONE	N/A	N/A
23	IMODES30	6	(a)	INITIALIZE ISS ON (OFF)	N/A
23	IMODES30	7-15	NONE	N/A	N/A
27	CDUX	1-15	(j)	CDUX XXX. XX DEG	N/A
28	CDUY	1-15	(j)	CDUY XXX. XX DEG	N/A
29	CDUZ	1-15	(j)	CDUZ XXX. XX DEG	N/A
31	CDUT	1-15	(j)	CDUT XX. XXX DEG	N/A
32	CDUS	1-15	(j)	CDUS±XXX. XX DEG	N/A
37	REDOCTR	1-15	CONVERT TO DECIMAL	REDOCTR XXXXX	1
38	FAILREG	1-15	DISPLAY IN OCTAL	FAILREG XXXXX	N/A
30	OPTMODES	1	NONE	N/A	N/A
30	OPTMODES	2	(a)	IGN OCDU FAIL ON (OFF)	N/A
30	OPTMODES	3	(a)	OPT ZEROING ON (OFF)	N/A
30	OPTMODES	4-5	(c)	OPT SWITCH XXX	N/A
30	OPTMODES	6-15	NONE	N/A	N/A
51	DRIFTO	1-15	CONVERT TO DECIMAL	V DRIFTO±XXX. XX MERU	$1000/2^{14}$
53	DRIFTI	1-15	CONVERT TO DECIMAL	S DRIFTI±XXX. XX MERU	$1000/2^{14}$
55	DRIFTT	1-15	CONVERT TO DECIMAL	E DRIFTT±XXX. XX MERU	$1000/2^{14}$
50	ANGZ	1-15	CONVERT TO DECIMAL	ANGZ±. XXXXX	$1/2^{14}$

TABLE 224A-2

WORD NO.	WORD NAME	BITS	DATA MANIPULATION See Notes (-)	DISPLAY	SCALE FACTOR
61	ANGY	1-15	CONVERT TO DECIMAL	ANGY±. XXXXX	$1/2^{14}$
63	ANGX	1-15	CONVERT TO DECIMAL	ANGX±. XXXXX	$1/2^{14}$
73	PIPAN	1-15	CONVERT TO DECIMAL	PIPAN±XXXXX	1
75	PIPAE	1-15	CONVERT TO DECIMAL	PIPAE±XXXXX	1
77	UPLOCK	1	(a) (d)	UPLOCK ON (OFF)	N/A
77	UPLOCK	2-15	NONE	N/A	N/A
90	DSTAB+11	1-3	NONE	N/A	N/A
90	DSTAB+11	4	(a)	NO ATTITUDE ON (OFF)	N/A
90	DSTAB+11	5	NONE	N/A	N/A
90	DSTAB+11	6	(a) (d)	GIMBAL LOCK ON (OFF)	N/A
90	DSTAB+11	7	NONE	N/A	N/A
90	DSTAB+11	8	(a)	TRACKER FAIL ON (OFF)	N/A
90	DSTAB+11	9	(a)	PROGRAM ALM ON (OFF)	N/A
90	DSTAB+11	10-15	NONE	N/A	N/A
91	TIME 2 (MS)	1-15	(e) (f) CONVERT	CMC TIME XXXX HRS XX MIN	1/360,000
92	TIME 1 (LS)	1-15	TO DECIMAL	XX. XX SEC	
93	CHNL 11	1	(a)	ISS WARNING ON (OFF)	N/A
93	CHNL 11	2	(b)	COMPUTER	N/A
93	CHNL 11	3	(b)	UPLINK	N/A
93	CHNL 11	4	(a)	TEMP CAUTION ON (OFF)	N/A
93	CHNL 11	5	(a)	KEY RELEASE ON (OFF)	N/A
93	CHNL 11	6	(a) (g)	FLASH VERB-NOUN ON (OFF)	N/A
93	CHNL 11	7	(a) (h)	OPERATOR ERR ON (OFF)	N/A
93	CHNL 11	8-12	NONE	N/A	
93	CHNL 11	13	(a)	ENGINE ON ON (OFF)	N/A
93	CHNL 11	14-15	NONE	N/A	N/A
94	CHNL 12	1	(a) (C19)	ZERO OPT CDUS ON (OFF)	N/A
94	CHNL 12	2	(a) (C19)	ABL OPT ER CTR ON (OFF)	N/A
94	CHNL 12	3	NONE	N/A	N/A
94	CHNL 12	4	(a) (C19)	COARSE ALIGN ON (OFF)	N/A
94	CHNL 12	5	(a) (C19)	ZERO ICDUS ON (OFF)	N/A

TABLE 224A-2 (Continued)

WORD NO.	WORD NAME	BITS	DATA MANIPULATION See Notes (-)	DISPLAY	SCALE FACTOR
94	CHNL 12	6	(a) (C19)	IMU ERR CTR ON (OFF)	N/A
94	CHNL 12	7	NONE	N/A	N/A
94	CHNL 12	8	(a) (C19)	TVC ENABLE ON (OFF)	N/A
94	CHNL 12	9	(a)	SAT TAKOVR ABL ON (OFF)	N/A
94	CHNL 12	10-12	NONE	N/A	N/A
94	CHNL 12	13	(a)	SAT INJ SEQ ST ON (OFF)	N/A
94	CHNL 12	14	(a)	SAT CUTOFF ON (OFF)	N/A
94	CHNL 12	15	(a)	ISS TRNON COMP ON (OFF)	N/A
95	CHNL 13	1-4	NONE	N/A	N/A
95	CHNL 13	5	(a)	INHIBIT UPLINK ON (OFF)	N/A
95	CHNL 13	6-7	NONE	N/A	N/A
95	CHNL 13	8	(a)	BMAG CTR ABL ON (OFF)	N/A
95	CHNL 13	9	NONE	N/A	N/A
95	CHNL 13	10	(a)	TEST ALARMS ON (OFF)	N/A
95	CHNL 13	11	(a)	ABL CMC STBY ON (OFF)	N/A
95	CHNL 13	12-15	NONE	N/A	N/A
97	CHNL 30	1	(a)	ULLAGE OFF (ON)	N/A
97	CHNL 30	2	(a)	SM SEPARATE OFF (ON)	N/A
97	CHNL 30	3	(a)	SPS READY OFF (ON)	N/A
97	CHNL 30	4	(a)	SIVB SEP/ABT OFF (ON)	N/A
97	CHNL 30	5	(a)	LIFTOFF OFF (ON)	N/A
97	CHNL 30	6	(a)	GUIDNCE REF RL OFF (ON)	N/A
97	CHNL 30	7	(a)	OPT CDU FAIL OFF (ON)	N/A
97	CHNL 30	8	NONE	N/A	N/A
97	CHNL 30	9	(a)	IMU OPERATE OFF (ON)	N/A
97	CHNL 30	10	(a)	S/C CTL SATURN OFF (ON)	N/A
97	CHNL 30	11	(a)	IMU CAGE OFF (ON)	N/A
97	CHNL 30	12	(a)	ISS CDU FAIL OFF (ON)	N/A
97	CHNL 30	13	(a)	IMU FAIL OFF (ON)	N/A
97	CHNL 30	14	(a)	ISS TRNON RQST OFF (ON)	N/A
97	CHNL 30	15	(a)	TEMP IN LIM OFF (ON)	N/A

TABLE 224A-2 (continued)

Notes:

a) If the bit indicated equals 1, display the word underlined. If the bit indicated equals 0, display the word parenthesis. The "OFF" state replaced by a blank state is also acceptable.

b) If the bit indicated equals 1, set the SGS discrete that displays the word in the display column. If the bit equals 0, remove the appropriate SGS discrete.

c) Display the following:

BIT 4	BIT 5	"XXX" DISPLAY
0	0	OFF
0	1	ZER
1	0	CMC
1	1	MAN

d) Store bit STATUS for G&N 631.

e) Combine the 14 magnitude bits of the most significant part (MS) with 14 magnitude bits of the least significant part (LS). The decimal conversion should be made only after the two parts of the double precision word have been sign checked. The signs appear in bit 15 of each word.

f) Store values of TIME 1, TIME 2 and RANGE TIME for G&N 602.

g) Store bit status for G&N 622A and G&N 622.

h) Store bit status for G&N 631.

i) Treat CDUT as an unsigned 15 bit counter. If $CDUT_8$ is greater than or equal to 61740_8, form $CDUT_8 - 61740_8$, convert to decimal, and multiply by $90°/2^{15}$. Display result as CDUT. If $CDUT_8$ is less than 61740_8, form $CDUT_8 + 60420_8$, convert to decimal and multiply by $90°/2^{15}$. Display result as CDUT.

j) Treat this word as an unsigned 15 Bit counter, convert to decimal and multiply by $360°/2^{15}$.

C19) These bits must also be displayed as follows: ISS Mode X_8 X_7 X_6 X_4 X_2 X_1 where Xn is a "0" or "1" for the bit indicated by the subscript.

Verify: Prior to and upon completion of the Uplink Transmissions, the status of "Operator Error" and "Uplock" will be checked. An "ON" state for either or both of these bits will result in a Non-Verify. In addition, each Uplink Transmission is to be verified via CSR Verify Response. A non-verify response for any of the above conditions should be indicated by a CRT display of "TIME ERROR 1".

Store: T_{R_1}, E_p, T_{HRS}, and K for inputs to G&N 602

CRT Display: "TIME EPOCH XXX HRS XX MINS XX.XXX SECS"

Operator Action: Console Operator: When Clock Initialization Program is desired, perform the C-START entries before R-START call-up of G&N 601 is made. Make sure there is no other major Uplink Activity at this time.

Spacecraft Operator: No activity required.

Uplink Requirements: See COMPUTATION SEQUENCE.

Downlink Requirements: Measurement ID: Not applicable.

Tolerance: Not applicable.

Remarks: Definition of terms used in this subprogram are as follows:

T_{R_1} - Range Time (hrs, mins, secs, ms)

E_p - Preset time for GC clock (hrs, mins, secs, ms)

T_{RP} - Range time at which E_p is to be inserted (hrs, mins, secs, ms).

T_E - Time to Epoch (hrs, mins, secs, ms)

K - Transmission delays (ms)

LOC - Location (octal) of address in erasable GC memory.

T_{HRS} - Range time truncated to Hrs.

Keycode Complement

XXXXX — 5 Bit Keycode | $\overline{\text{XXXXX}}$ | XXXXX — 5 Bit Keycode

Figure 603-1. LGC UPLINK FORMAT

1	10001	01110	10001	(VERB)
1	00101	11010	00101	(5)
1	00101	11010	00101	(5)
1	11100	00011	11100	(ENTER)
1	SIGN	$\overline{\text{SIGN}}$	SIGN	(SIGN OF Δt)
1	$0_1 0_1 0_1 0_1 0_1$	$\overline{0_1 0_1 0_1 0_1 0_1}$	$0_1 0_1 0_1 0_1 0_1$	(1st DIGIT OF Δt)
1	$0_2 0_2 0_2 0_2 0_2$	$\overline{0_2 0_2 0_2 0_2 0_2}$	$0_2 0_2 0_2 0_2 0_2$	(2nd DIGIT OF Δt)
1	$0_3 0_3 0_3 0_3 0_3$	$\overline{0_3 0_3 0_3 0_3 0_3}$	$0_3 0_3 0_3 0_3 0_3$	(3rd DIGIT OF Δt)
1	$0_4 0_4 0_4 0_4 0_4$	$\overline{0_4 0_4 0_4 0_4 0_4}$	$0_4 0_4 0_4 0_4 0_4$	(4th DIGIT OF Δt)
1	$0_5 0_5 0_5 0_5 0_5$	$\overline{0_5 0_5 0_5 0_5 0_5}$	$0_5 0_5 0_5 0_5 0_5$	(5th DIGIT OF Δt)
1	11100	00011	11100	(ENTER)
1	11001	00110	11001	(KEYBOARD RELEASE)

Verify: Prior to and upon completion of the Uplink Transmission, the status of the "Operator Error" and "Uplock" will be checked. An "ON" state for either or both of these bits will result in a non-verify. In addition, each uplink transmission is to be verified via CSR Verify response. A non-verify response for any of the above conditions should be indicated by a CRT display of "TIME ERROR 8" through R-31 and Module activation.

Operator Action:

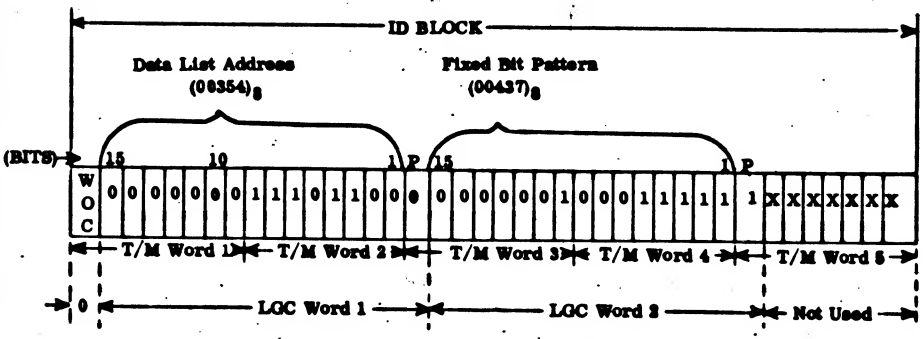
Operator Action: Console Operator: When G&N 603 is desired, call-up is made through R-START Module activation.

Spacecraft Operator: No activity required.

WORD 4	8	7	6	5	4	3	2	1
WORD 5	P	X	X	X	X	X	X	X

Where WOC = Word order code (1-bit)
P = Parity (LGC word has odd parity)
X = Not used

The ID block should normally appear once every 100 prime frames and contains a zero WOC, two LGC 16-bit words including parity bits (P) and seven unused bit positions (X). LGC word 1 contains the data list address in bit positions 15-1 [illegible] and parity (P) in bit position zero. LGC [illegible] Word 2 contains a fixed bit pattern sync word $(00437)_8$ in bit positions 1-15 and Parity (P) in bit position zero. LGC Word 1 precedes LGC Word 2 in the data block transmission. The word order code (WOC) bit contains a 0 for all LGC ID blocks. An example block and word formats is shown below.



The following ID groups shall be accepted as valid: [illegible] one WOC, two LGC [illegible] Downlist No. [illegible] (ID Word)8 [illegible] (SYNC Word)8 [illegible] (X). Table No. [illegible] LGC Word [illegible] precedes LGC 00354 [illegible] the data block 00437 [illegible] mission. The [illegible] code [illegible] 621-200-1

The data blocks (normally 99 between ID blocks) contain a WOC, two LGC 16-bit words including parity bits (P) and seven unused bit positions (X).

LGC Word 1 precedes LGC Word 2 in the data block transmission. The word order code (WOC) bit contains a 1 for all LGC Data Blocks. The block and word formats are specified as follows:

. 621-200.2

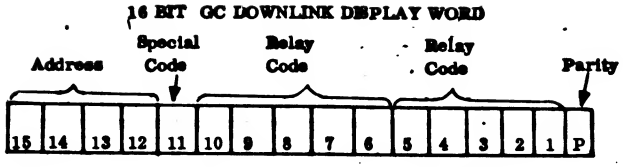


FIGURE 622-200-1

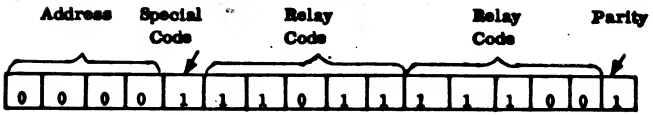


FIGURE 622-200-2

TABLE 622-200-1

TABLE OF DISPLAY WORDS

DSPTAB	Address Bits 15-12 Binary Code	Special Code Bit 11	Display Name Relay Code for Bits 10-6	Display Name Relay Code for Bits 5-1
+10D	N	- -	MD1	MD2
+ 9D	O	- -	VD1	VD2
+ 8D	T	- -	ND1	ND2
+ 7			- -	R1D1
+ 6	U	+R1	R1D2	R1D3
+ 5	S	-R1	R1D4	R1D5
+ 4	E	+R2	R2D1	R2D2
+ 3	D	-R2	R2D3	R2D4
+ 2		- -	R2D5	R3D1
+ 1		+R3	R3D2	R3D3
+ 0		-R3	R3D4	R3D5

TABLE 622-200-2

5 BIT RELAY CODES FOR NUMERIC CHARACTER DISPLAY

BLANK	00000
0	10101
1	00011
2	11001
3	11011
4	01111
5	11110
6	11100
7	10011
8	11101
9	11111

TABLE 622-200-3

ERROR DESCRIPTION

ERROR	CRT DISPLAY	STANDARD MESSAGE ON FILE TAPE
A word has appeared containing a relay code which is not in Table 622-200-2	RELERRQ	622 RELERR1, 16-bit word, time tag, and word count

TABLE 024B-1 (CONTINUED)

WORD NUMBER	WORD NAME	BIT (#)	DATA MANIPULATION See Note ()	DISPLAY
99	CHNL 32	1	(a)	JETS 2-4 FAIL ____ (ON)
99	CHNL 32	2	(a)	JETS 5-6 FAIL ____ (ON)
99	CHNL 32	3	(a)	JETS 1-3 FAIL ____ (ON)
99	CHNL 32	4	(a)	JETS 6-7 FAIL ____ (ON)
99	CHNL 32	5	(a)	JETS 14-16 FAIL ____ (ON)
99	CHNL 32	6	(a)	JETS 13-15 FAIL ____ (ON)
99	CHNL 32	7	(a)	JETS 9-12 FAIL ____ (ON)
99	CHNL 32	8	(a)	JETS 10-11 FAIL ____ (ON)
99	CHNL 32	9	(a)	GIM OFF ____ (ON)
99	CHNL 32	10	(a)	APP GIM FAIL ____ (ON)
99	CHNL 32	11-15	None	N/A
100	CHNL 33	1	None	N/A
100	CHNL 33	2	(a)	RR ON/AUTO ____ (ON)
100	CHNL 33	3	(a)	RR RANGE LO-SC ____ (ON)
100	CHNL 33	4	(a)	RR DATA GOOD ____ (ON)
100	CHNL 33	5	(a)	LR ALT D GOOD ____ (ON)
100	CHNL 33	6	(a)	LR POS 1 ____ (ON)
100	CHNL 33	7	(a)	LR POS 2 ____ (ON)
100	CHNL 33	8	(a)	LR VEL D GOOD ____ (ON)
100	CHNL 33	9	(a)	LR ALT LO-SC ____ (ON)
100	CHNL 33	10	(a)	BLOCK UPLINK ____ (ON)
100	CHNL 33	11	(a)	UPLINK TOO FAST ____ (ON)
100	CHNL 33	12	N/A	N/A
100	CHNL 33	13	(a)	PIPA FAIL ____ (ON)
100	CHNL 33	14	(a)	LGC WARNING ____ (ON)
100	CHNL 33	15	(a)	OSC ALARM ____ (ON)

TABLE 624-200-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION			DISPLAY	
			Code*	Scale Factor	See Note ()		
33	LMPCMD +6	1-15	C3	1	(a)	XXX	
34	LMPCMD +7	1-15	C3	1	(a)	XXX	
35	LMP IN	1-15	C3	1	(c)	LMP IN X	
36	LMP OUT	1-15	C3	1	(c)	LMP OUT X	
37	SPARE	1-15					
38	SPARE	1-15					
39	UPVERB	1-15	N/A				N/A
40	COMPNUMB	1-15	N/A				N/A
41	STATE COUNT	1-15	C3	1	(b)	STCN TRXX	N/A
42	UPOLDMOD	1-15	N/A				N/A
43	ST BUFF +0	1-15	C6			R XXXXX	
44	STBUFF +1	1-15	C6			XXXXX	
45	ST BUFF +2	1-15	C6			XXXXX	
46	ST BUFF +3	1-15	C6			XXXXX	
47	ST BUFF +4	1-15	C6			XXXXX	
48	ST BUFF +5	1-15	C6			XXXXX	
49	ST BUFF +6	1-15	C6			V XXXXX	
50	ST BUFF +7	1-15	C6			XXXXX	
51	ST BUFF +8D	1-15	C6			XXXXX	

* Refer to Table 624-200-2

Notes:

a. The resulting decimal numbers will not exceed 3 digits for words 27 thru 34 and 127 thru 134.

b. The resulting decimal numbers will not exceed 2 digits, for words 135 thru 140 and word 147.

c. The resulting decimal numbers will not exceed 1 digit for words 35, 36, 135, and 136.

d. Flash verb numbers and noun numbers.

Title: Angle Converter G&N 652, GN 652

Part Of: Communication Program

Purpose: This program converts the 1X resolver sin and cos sin and cos PCM values to degrees for display on the CRT. This subprogram specification is identical to the specification for G&N 152A (See 4-152A1.2)

Title: ACE-S/C Error Reset Program G&N 671

Part Of: Downlink Program

Purpose: This subprogram resets the error displays on the CRT display unit to give a "no error" indication for the ACE-S/C subprograms utilized with the LEM Block II G&N System.

Calling Sequence: Entry: This subprogram operates under executive control and is initiated from the R-START Module specified in the PRPS or PRD.

Exit: Return to Downlink Executive Program after error displays are reset.

Computation Sequence: The error displays reset by this subprogram are listed below, along with the ACE-S/C subprogram that generates them during its operation. The CRT page and line location for each error display is detailed in the Program Requirements Process Specification.

Error Indication	G&N Program Number
TIME ERROR (1)	601
TIME ERROR (2, 4)	602
TIME ERROR (3)	603
SYNCERR (1, 2)	621, 221 or 621-200
WORDERR (1, 2, 3, 4, 5, 9)	221
RELERR (1)	622 or 622-200
PARERR (1)	631
KEYERR (1, 2)	631
VERROR (1, 2, 3, 4, 5)	632
FSERR (1)	681
WORDERR (1, 2)	621-200
WORDERR (1, 2, 3, 4, 5, 6, 7)	621

Each error display consists of a variable segment (underlined) which signifies the type of error condition occurring in a particular ACE-S/C subprogram, and a fixed title segment. When initiated by the operator, this subprogram will blank out the variable segments of the error displays.

APOLLO G&N Specification
ND1002319 REV F
Original Issue Date:
Release Authority: TDRR 31543
Class A Release

ACE-S/C COMPUTER SUBPROGRAM

SPECIFICATIONS FOR APOLLO

CM AND LM G & N TESTING

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	APPROVALS AC	APPROVALS NASA
12/8/66	A	32263	2, 3, 81, 115, 199, 200, 206, 209, 214-345.	EA	WLS
			Was 345 pages, Now 352 pages. ROG/AC		
12/21/66	B	32361	266, 270 ROG/AC	JP	--
1/6/67	C	32582	3, 144, 145, 185, 228-352 was 352 pages	EA	--
			now 380 pages ROG/AC		
1/26/67	D	32756	292, 295 ROG/AC	EA	--
3/2/67	E	33114	3, 265-267, 269, 274, 280, 292,	EA	--
			310-312, 332, 336, 351, 377 and 378	ROG/AC	
6/8/67	F	33950	3, 235-251, 256, 268, 269, 272, 277,	EA	--
			292, 295, 320, 321, 327, 328, 332, 333		
			344, 346, 350, 354-358; was 380, now 390 pages. ROG/MV		

This specification consists of 390 total pages.

PROVALS	NASA/MSC	10/13/67	F.E.T. ACED

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G&N NUMBER	TITLE	SECTION
152A	Angle Converter Processing, Block 1 Mod 1	4-152A.1
171	ACE-S/C Error Reset Program	4-171.1
181	PIPA Switching and Stabilization Response Test.	4-181.1
210	G & N Downlink Edit Program Block II and LEM	4-210.1
221A	AGC Downlink Format Program Block 2	4-221A.1
224A	CGC Downlink Interpretation Program, Block II	4-224A.1
601	Guidance Computer Clock Initialization Program	4-601.1
602	Guidance Computer Time Verification Program	4-602.1
603	Guidance Computer Time Correction Program	4-603.1
621	Guidance Computer Downlink Format Program	4-621.1
621-200	Guidance Computer Downlink Subprogram	4-621-200.1
622A	Guidance Computer Display Program	4-622A.1
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624A	LEM Downlink Interpretation Program	4-624A.1
624B	LGC Downlink Interpretation Program	4-624B.1
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631	Guidance Computer Uplink Verification Program	4-631.1
632	Special K-Start Load-Verify, Verify, and Dump Program	4-632.1
641	G & N High Rate Channel Control Program	4-641.1
652	Angle Converter Angle Processing	4-652.1
671	ACE-S/C Error Reset Program	4-671.1
681	PIPA Switching and Stabilization Response Test.	4-681.1
721	Downlink Format & Interpretation Subprogram	4-721.1
722	Display Program (DSPTAB)	4-722.1

Title: G&N Downlink Edit Program, G&N 210.

Purpose: The G&N Downlink Edit Program strips outs, interprets, and presents all or any part of the Command Guidance Computer (CGC) and the LEM Guidance Computer (LGC) data recorded on the PCM Data Tape.

Input: The inputs to this program are:

1) PCM Data Tape or Compressed Data Tape containing CGC/LGC data.
2) Edit Parameters (cards or tape)
3) Control cards

Output: The output from this program is a printed listing of CGC/LGC Downlink data taken from the PCM Data Tape or Compressed Data Tape for the intervals requested and processed and displayed in the manner defined by the Edit Parameters.

General Program Description: The G&N 210 is divided into two segments to minimize the impact of changes in the input data format. The two segments are:

1) EXECUTIVE SEGMENT - This segment prepares the Edit Parameters for use, processes the Control Cards, extracts the CGC/LGC data from the PCM Data Tape or Compressed Data Tape for the intervals defined, validates this data and transmits it to the next segment.

2) PRESENTATION SEGMENT - This segment receives the CGC/LGC data and the Edit Parameters from the Executive Segment and processes and prints out this data in the manner prescribed by the Edit Parameters.

Printing: Printing will be once every complete cycle through the Downlink list. The Downlink Edit Format Tables will define from 1 to 99 lines to be printed on one (7 to 50 lines) or two (51 to 99 lines) pages. Six lines or less define a subpage to be printed under line count control. As many full subpages as possible will be fit per page.

Execution: In most cases it will not be necessary to see all the data on the PCM Data Tape or Compressed Data Tape. The intervals to be processed will be specified in the Zulu Time as it appears on the PCM Data Tape or Compressed Data Tape and will be input to the program on control cards.

Data Rate: CGC/LGC Data is recorded on analog PCM Data Tapes at bit rates of:

1) 204.8KBS
2) 51.2KBS
3) 1.6KBS

This program must be able to process data at any and all of these rates.

Title: EXECUTIVE SEGMENT

Purpose: The purpose of the Executive Segment is to prepare the Edit Parameters for use by the Presentation Segment, processes the Control Cards, and to extract and validate the required CGC/LGC data from the PCM Data Tape.

Input: The inputs to this segment are:

1) Downlink Edit Format and Requirements Tables (Edit Parameters)
2) Data Definition, Title and Time Cards (Control Cards)
3) PCM Data Tape or Compressed Data Tape containing the CGC/LGC data to be processed.

Output: The outputs from this segment are:

1) Edit Parameters for use by the Presentation Segment
2) CGC/LGC data extracted from the PCM Data Tape or Compressed Data Tape
3) Error signals for any discrepancies found in the Edit Parameters, the Control Cards, and the CGC/LGC data.

Normal Exit: The normal exit from this segment is to the Presentation Segment. The normal program halt occurs when the last time interval has been satisfied.

Error Exit: Error signals are generated for discrepancies found in the Input Cards, PCM or Compressed Data Tape Data. The Error Exit is to the Presentation Segment.

Description: The CGC/LGC data consists of two types of words:

1) Identification Words (2): These words indicate the type of downlink transmission (List) and signal the start of the data transmission.
2) Data Words (98 to 398): Actual CGC/LGC words. The position of a data word in a List identifies its content. There is a unique Word Order Code associated with each type of word.

The first card to be input is the Data Definition Card. This card identifies the position(Time Slot) of the CGC/LGC words in a Prime Frame of PCM Telemetry Data, and the length of the downlist (100 to 400).

The List being sent changes during the various phases of a mission program. A set of Edit Parameters is required for each List. The number of Lists to be used during the missions utilizing Block II Computers is not known; as a preliminary estimate, this program should be able to accomodate up to twenty different lists of variable lengths from 100 to 400 words.

A set of Edit Parameters for any List will consist of:

1) List ID card - This card contains the bit configuration (in octal) of the ID Words of the List for which the tables following this card are to be used.

2) R cards - These cards define the print format of the data for the particular list.

3) ENG card - These cards define the English phrase interpretations for the particular List.

4) E Cards - These cards define the processing requirements for the particular List.

5) END Card - This card is the last card of the set of Edit Parameters for the particular List.

This sequence of cards will be repeated for each List.

Run cards to be input with each run will consist of:

1) G&N card - This card will contain the description of the particular run and will be used as a page heading on the output listing.

2) TIME cards - These cards will designate the data to be processed. Each card will contain a start and a stop time in hours, minutes, and seconds. If more than one TIME card is used, the times specified will not overlap and will be in sequence.

3) END OF RUN card - signals the end of the Control Cards.

Appropriate validity checks should be made on the format of these cards. Any card error will suspend the processing of and PCM or Compressed Data Tape Data, but all cards should be scanned and all errors displayed even though no data will be processed.

Usage of the Downlink Edit Program - Block I has shown that the Edit Parameters tend to be fixed once the data content of the Downlink is known. New sets of Edit Parameters will be used only for special applications. The Executive Segment should process the Downlink Edit Format Tables and the Downlink Requirements Tables and save them on tape so that subsequent runs with the same type of data may be made with no reprocessing of those cards.

Time: There is a time signal on the PCM Data Tape and the Compressed Data Tape and the time of transmission of each CGC/LGC word can be determined. This time is matched to the time intervals requested to determine what data is to be processed. Data should be processed from the first ID following the start time to the end of the Downlist after the stop time. The time occurrence of the ID Word must be available to the Executive Segment.

Data Form: The CGC/LGC transmitts blocks of five 8 bit words into the PCM stream of telemetry. These forty bits contain the data to be processed. The Downlist consists of 100 to 400 CGC/LGC words, each block representing 2 of these words. The first block of a Downlist contains the ID Words. These words identify the List being transmitted. Following the ID Words are 98 to 398 Data words. CGC/LGC words are 16 bits in length and are configured as:

S/15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 P

where: bit 15 is the Sign bit for numeric data bits
14 thru 1 are the data bits for numeric data
P is the Parity (Odd) bit.

Validation: The Validity checks to be made on the CGC/LGC data are:

1) Check - Out of Sync signaled by DECOM
Action - Message SYNCERR1, indicate which words are out of sync but process anyway.

2) Check - Over 98 to 398 data words since ID words
Action - Message SYNCERR2, process first 98 to 398 data words and ignore the rest until ID words received.

3) Check - ID Words received before 98 to 398 data words were received since last ID Words.
Action - Message SYNCERR3, process data words received begin next Downlist with new ID Words.

4) Check - Parity incorrect in first CGC/LGC word in block
Action - Message WORDERR1, display the 40 bits in Octal and the index number. Do not process the word in error.

5) Check - Parity incorrect in second CGC/LGC word in block
Action - Message WORDERR2, display the 40 bits in Octal and the index number. Do not process the word in error.

6) Check - First ID Word, bits 15 to 11 Invalid
Action - Message WORDERR3

7) Check - First ID Word, bits 10 to 1 Invalid
Action - Message WORDERR4, Invalid ID, display the 40 bits in octal and the index number. Cycle until next ID received.

8) Check - Second ID Word Invalid
Action - Message WORDERR5, display 40 bits in octal. If no error was found in the first ID Word, the ID will be considered Valid and ID Word 1 will be used to determine the list being sent.

NOTE: WORDERR3 alone will not invalidate the ID. If no other ID errors are found, bits 10 to 1 of ID word 1 will determine the list being sent.

Title: PRESENTATION SEGMENT

Purpose: The Presentation Segment receives the 16 bit CGC/LGC words from the Executive Segment. These words are processed in the manner defined by the Downlink Requirements Tables and displayed in the manner defined by the Downlink Edit Format Tables.

Input: The inputs to this segment are:
1) Edit Parameters and ID Word configurations for all Downlists to be processed.
2) The 16 bit CGC/LGC Words.
3) Error indicators associated with the 16 bit words transmitted.

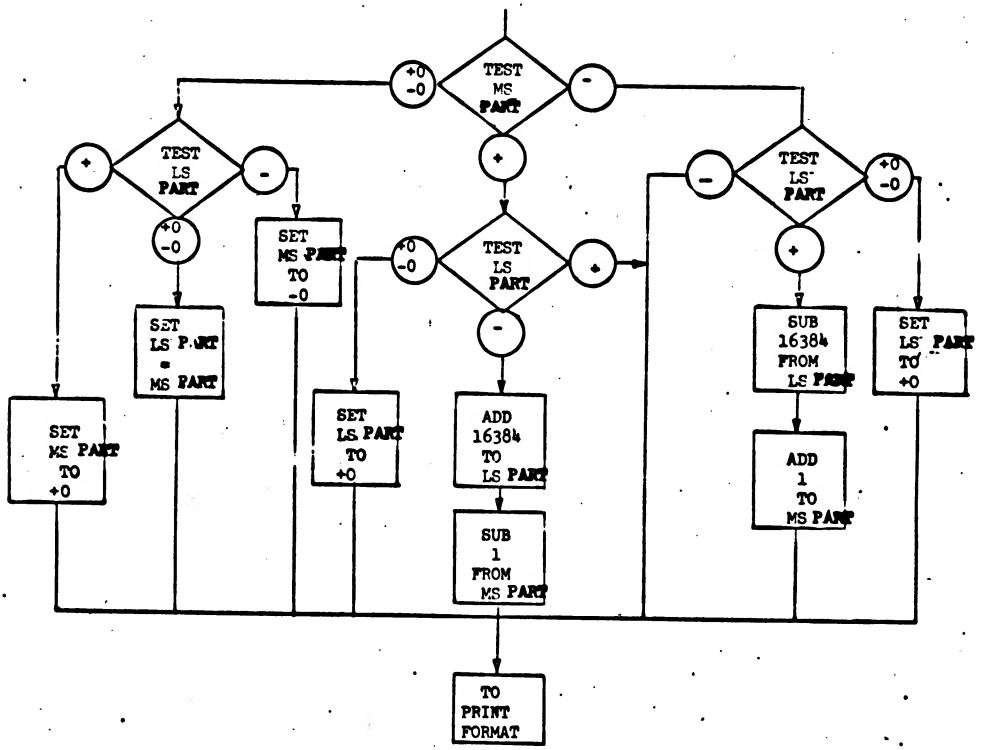
Output: The output from this segment is the printed listing in the formats defined by the Edit Parameters and any error messages generated.

Exits: The normal and the error exits from this segment are to the Executive Segment.

Description: This segment receives the 16 bit CGC/LGC words and any error signals from the Executive Segment. Each word is examined to determine if it is an ID Word or a Data Word. When the ID Words are received, the time of their occurrence is printed as positioned by an E card. The Edit Parameters for data following the particular ID are made ready for processing. The ID words may be processed as data words for printing. When Data Words are received, a check of the Edit Parameters will determine if the word is to be used, and if so, how to process it. Error signals generate output messages. All CGC/LGC words are treated as binary fractions with the binary point between the 15th and 14th bits of the word. Double Precision quantities will require that processing be held up until both words have been received.

Note that the most significant part and the least significant part of a double precision word do not necessarily have the same sign. Use the following diagram for a processing technique.

Method For Handling Double Precision Words:



Card Formats:

Data Definition Card - This card locates the two sixteen bit CGC/LGC words and the Word Order Code (WOC) contained in the 40 bits defined. This card also will define the representative WOC bit for ID Words. That is, the bit (0 or 1) indicated will be in each bit position of the WOC for ID Words. The 5-8 bit words will be considered as individual bits numbered 1 to 40 with the left most bit of the first word called bit 1 and numbered consecutively to the right most bit of the fifth word, bit 40.

Columns	Contents	Comments
1 to 4	DATA	defines card type
9 to 11	PCM	comment
13 to 19	XXX-XXX	First and last time slots of the 5-8 bit G&N PCM Words
22 to 25	WRD1	comment
27 to 31	XX-XX	first and last bit position of CGC/LGC word 1
34 to 37	WRD2	comment
39 to 43	XX-XX	first and last bit position of CGC/LGC word 2
46 to 48	WOC	comment
50 to 54	XX-XX	first and last bit position of word order code
57 to 61	IDWOC	comment
63	X	WOC representative bit for ID Words
70 to 72	XXX	Length of Downlist

Comments need not be checked for. The CGC/LGC words should be 16 bits in length, the word order code may be from 1 to 8 bits. All WOC bits will be identical if more than one is specified. The representative WOC bit for ID words is supplied. Data word WOC is assumed to be the complement of the ID WOC. See card example page for further clarification.

Downlink Edit Format Tables:

A Downlink Edit Format Table is required for each Downlist to be processed. This table specifies the fixed format layout of the edit listing. A field width of 120 print characters is required. The spacing alloted between the title entries of this table is for the insertion of the CGC/LGC data as processed by the Presentation Segment. This table is composed of R cards. These cards provide the titled entries for the edit listing. No more than two cards are used to define any single line of the listing. The set of R cards for any Downlist will not define over 50 lines including spacing for each page.

Columns	Contents	Comments
1	R	defines card type
6, 7	XX	line sequence number
8	y	print control
9 to 80		fixed format layout

where: XX R cards for a particular List are in sequence by this number. This number is used by the E cards to identify the lines on which the processed data will be displayed.

y = blank or 1, skip one line after printing
= 2, skip two lines after printing
= 9, fixed format layout of this card is the right most portion of the previously defined line

If y is blank, 1, or 2, columns 9 thru 80 of the card will be printed in print positions 1 to 72. If y is 9, columns 9 thru 56 will be printed in print positions 73 to 120. A one line skip is assumed if the line sequence number is unique.
If y is 9, and the line sequence number is equal to the line sequence number of the preceeding card, then this card defines print positions 73 to 120 of the previous line.

```
EG  R 012
    R 019
    R 02
    R 039
    R 04
    R 049
```

Will define 5 lines:
Line 1 of Print Positions 1 to 120
Line 2 of all blanks
Line 3 of Print Positions 1 to 72
Line 4 of Print Positions 73 to 120
Line 5 of Print Positions 1 to 120

Note that the maximum occurrence of equal line sequence numbers is twice: Once with print control of Blank, 1, or 2; and again with print control of 9.

Downlink Requirements Tables:

A Downlink Requirements Table is needed for each Downlist to be processed. This table defines the specific entries required for the edit listing by referencing the index number (word position in Downlist) of the words to be processed. This table specifies the exact placement, in terms of print positions, of each data entry in the fixed edit format defined by the Downlink Edit Format Table for this Downlist. This table also specifies the processing required for each data entry in the output. A Downlink Requirements Table is composed of E cards and ENG cards.

Columns	Contents	Comments
1	E	defines card type
9, 10	XX	line number (match to R card line sequence number)
12 to 18	XXX-XXX	print positions in output line where this entry is to be displayed.
25 to 30	EQUALS	
32 to 34	XXX	index number (001 to 400)
	For quantities to be displayed in decimal:	
36 to 62	DP or FP (Double or Single Precision), Scale Factor (sign, decimal point, one to ten decimal digits), power (E, sign, one or two decimal digits), S or NS (if S, print sign; if NS treat word as 15 bit unsigned number), MSB (for double precision, indicates most significant bits)	
	For other quantities:	
36 to 50	XX or XX-XX or XX, XX-XX (bit positions to be considered - leading zeros not supplied) OCTAL (print bits indicated in octal) or BINARY (print bits indicated in binary) or ENGn (Extract bits indicated and search English table specified for match and insert associated phrase in output), I or blank (I, if bit 15 of the word is a 1, the bits indicated must be complimented before processing; if field is blank or if bit 15 is 0, the bits indicated are used as is).	
	Fields will be separated by commas, and except where mentioned, leading zeros will be supplied.	

The ENGn cards contain English phrases to be inserted in the output listing when certain combinations of bits are present in key CGC/LGC words. The bits for comparison and the table to be searched are indicated by E cards.

Columns	Contents	Comments
1 to 3	ENG	defines card type
4	n	table number (n = 1 to 8)
8 to 23	1 to 16 binary characters that is the bit pattern for which the English phrase will be substituted (bits specified n in E card are extracted and compared to the non-blank columns - right justified to column 23)	

Downlink Requirements Tables:	Columns	Contents	Comments
	25 to 30	EQUALS	
	33 to 53	1 to 20 alphanumeric characters to be inserted in print positions defined in the E card - left justified to column 33. A $ in column 33 means that no phrase is to be inserted for the bit pattern matched.	

If the designated ENGn table is searched and no match is found, an error condition exists. A message, DOWNERR1 is printed along with the index number of the word that contained the bits that could not be matched and the word (16 bits) in octal.

NOTE: A special application of the E card will be used to position the time of the ID word in the edit listing. Index word 000 will indicate this time and it will be positioned in the normal manner. E.G.

E 06,018-037 EQUALS 000

Print GMT on the line defined by R 06 in print positions 018 through 037. The processing requirements for this word are already defined.

List Identification Card - This card is the first card of the set of Edit Parameters for a particular Downlist. The bit configurations of the ID Words, whose data will be processed according to the tables following this card, are contained in this card.

Columns	Contents	Comments
1 to 4	LIST	defines card type
7 to 12	XXXXXX	bit configuration in Octal of first ID word
15 to 20	XXXXXX	bit configuration in Octal of second ID word

The 16 binary bits are converted into 6 octal characters by adding two binary zeros to the right to make 18 binary bits E.G. (1100100001101111) will be in the card as 620674.

End Card - This card is the last card of the set of Edit Parameters for a particular Downlist.

Columns	Contents	Comments
1 to 3	END	defines card type

The Edit Parameters for each Downlist consist of: LIST ID card, R cards, ENGn cards, E cards and the END card in that order.

Cards Input for each run:

The page title card contains the run description, date, OCP, etc, and is printed once per page.

Columns	Contents	Comments
1 to 3	G&N	defines card type
5 to 75	page title	to be printed as the first line of each page.

The data to be processed are defined as a set of 1 to n time intervals. Each card contains the start and stop time of a data interval. For multiple intervals, the times will not overlap and will be in sequence.

Columns	Contents	Comments
1 to 4	TIME	defines card type
6, 7	XX	start time, hours
8, 9	YY	start time, minutes
10, 11	ZZ	start time, seconds
13, 14	TO	
16, 17	XX	stop time, hours
18, 19	YY	stop time, minutes
20, 21	ZZ	stop time, seconds

The last card to be input is the End of Run card.

Columns	Contents	Comments
1 to 10	END OF RUN	defines card type

Example 1

E 02, 018-026 EQUALS 062, DP, +.16777528E+5, S, MSB

E - specifies requirements equals card
02 - specifies the number of a R card entry in the Edit Format table which designates the line that this data is to be printed on.
018-026 - specifies the print positions of line 02 that this data is to be printed in
062 - specifies the position in the Downlink List (index number) that contains the data to be processed.
DP - specifies that the data is double precision
+.16777528 - specifies the numeric value of the scale factor
E+5 - specifies the power of the scale factor
S - specifies the data is a signed number
MSB - specifies that word 062 is the most significant bits of the double precision quantity.

This card requires that the 14 data bits of word 062 and the 14 data bits of word 063 be combined as previously described into a 28 bit binary fraction, converted to a decimal fraction, multiplied by 16777.528 and printed in positions 018 to 026 of line 02.

Example 2

E 61, 047-062 EQUALS 029, 7, 5-1, ENG2

E - specifies requirements Equals card
61 - specifies the number of the R card entry
047-062 - specifies the print positions of R 61 for display
29 - specifies the index number of the data
7, 5-1 - specifies the bits to be extracted from word 029
ENG2 - specifies the table of English phrases that is to be searched for the same pattern as the bits extracted.

This card requires that bits 7 and 5 thru 1 be extracted from word 029. These bits are then compared to the patterns that are part of English phrase table ENG2. When the bits are matched, the English phrase associated with that pattern is printed in print positions 047 to 062 of the line defined by R card 61.

Example 3

E 04, 109-109 EQUALS 012, 6, BINARY

E - specifies requirements Equals card
04 - specifies the number of a R card entry
109-109 - specifies the print position on line defined by R04
012 - specifies the index number of the data
6 - specifies the bit position to be extracted from word 12
BINARY - specifies that the bit be displayed in binary.

Example 4

E 06, 097-101 EQUALS 026, 15-1, OCTAL

E - specifies requirements Equals card
06 - specifies the R card line number
097-101 - specifies the print position in the line defined by R 06
026 - specifies the index number of the CGC/LGC data
15-1 - specifies the bits of word 012 to be processed
OCTAL - specifies that the data is to be printed in octal

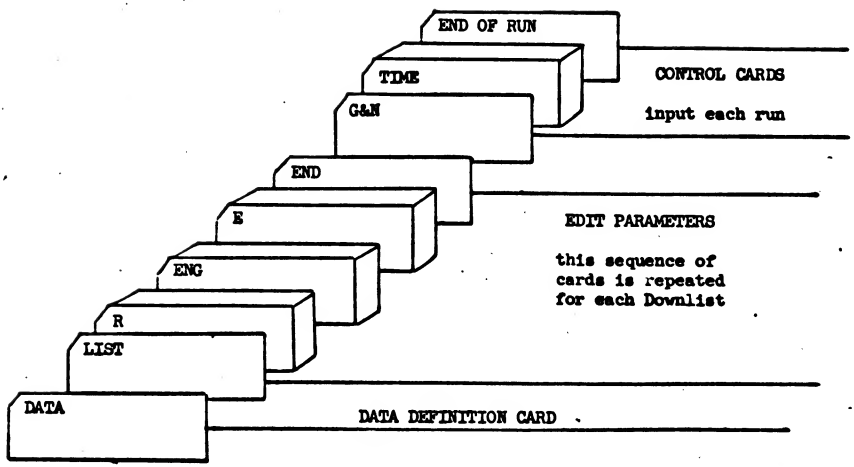
Example 5

ENG2 001001 EQUALS FINE ALIGN

ENG2 - specifies requirements English card
001001 - specifies the bit pattern that will be interpreted by the English phrase
FINE ALIGN - specifies the message that is to be printed in the print positions called out by the E card that refers to the ENG2 table.

This card is actually a sub-card to an E card. The E card specifies the bits of a CGC/LGC word to be compared to the various entries of the ENG2 table and the print positions for the message.

Input Card Deck Makeup:



Input Card Examples:

```
DATA  PCM 1032-0136  WRBUF 02-17  WRD2  15  33  MCC 01-01  EDMEM 11  INT 200
LIST  01162154 00437H
R     022AGC TIME  HRS  IMU MODE  AGC ID
ENG2  EQUALS  ZERO ENCODER  +.74565410142E+3 ,S ,MSB
E     02,0118-0126  EQUALS 0116 DP +.  18QE+3
E     45,0141-0120  EQUALS 0125 SP +.  ENG2,1
E     53,0139-0514  EQUALS 0260,17 S-1
E     05,0140-0140  EQUALS 0113 +1  BINARY
E     05,0119-0123  EQUALS 0113 +15-1 →OCTAL
END   CSM/LM RESIDUALS TIME MISSION SIMULATION  NSI-1202  ΔCP-K00135  6/6/66
G+N   1145112  TH 1153220
TLM   RUN
ENE
```

References:

1) AC Electronics Diagnostic Program Specification for CMC Block I (CMCD1) - G&N Downlink Edit, Block I

2) ACE S/C Subprogram Specification for the Downlink Format Program, LGC Block II (G&N 621)

3) ACE-S/C Subprogram Specification for the ACE G&N Downlink Edit Program (G&N 010)

TABLE 221A-1

Error Description	CRT Display
This indicates that Wordcnt has incremented beyond a specified limit.	SYNCERR 1
At this point Wordcnt should be 101, if an ID has been received in the correct sequence.	SYNCERR 2
Parity is incorrect in the first GC word in data block.	WORDERR 1
Parity is incorrect in the second GC word in data block.	WORDERR 2
ID word (bits 11 - 15) $\neq (00)_8$	WORDERR 3
Fixed bit pattern in ID word is illegal.	WORDERR 4
Invalid list address encountered after attempting to utilize second GC word to identify ID word.	WORDERR 5
Invalid list address encountered in the first GC word in data block.	WORDERR 6

TABLE 224A-2 (Continued)

WORD NO.	WORD NAME	BIT	DATA MANIPULATION See Notes (-)	DISPLAY	SCALE FACTOR
98	CHNL 31	1	(a)	+PITCH MAN ROT OFF (ON)	N/A
98	CHNL 31	2	(a)	-PITCH MAN ROT OFF (ON)	N/A
98	CHNL 31	3	(a)	+YAW MAN ROT OFF (ON)	N/A
98	CHNL 31	4	(a)	-YAW MAN ROT OFF (ON)	N/A
98	CHNL 31	5	(a)	+ROLL MAN ROT OFF (ON)	N/A
98	CHNL 31	6	(a)	-ROLL MAN ROT OFF (ON)	N/A
98	CHNL 31	7	(a)	+X TRANS OFF (ON)	N/A
98	CHNL 31	8	(a)	-X TRANS OFF (ON)	N/A
98	CHNL 31	9	(a)	+Y TRANS OFF (ON)	N/A
98	CHNL 31	10	(a)	-Y TRANS OFF (ON)	N/A
98	CHNL 31	11	(a)	+Z TRANS OFF (ON)	N/A
98	CHNL 31	12	(a)	-Z TRANS OFF (ON)	N/A
98	CHNL 31	13-14	NONE	N/A	N/A
98	CHNL 31	15	(a)	G/N CONTROL OFF (ON)	N/A
99	CHNL 32	1	(a)	+PITCH MIN IMP OFF (ON)	N/A
99	CHNL 32	2	(a)	-PITCH MIN IMP OFF (ON)	N/A
99	CHNL 32	3	(a)	+YAW MIN IMP OFF (ON)	N/A
99	CHNL 32	4	(a)	-YAW MIN IMP OFF (ON)	N/A
99	CHNL 32	5	(a)	+ROLL MIN IMP OFF (ON)	N/A
99	CHNL 32	6	(a)	-ROLL MIN IMP OFF (ON)	N/A
99	CHNL 32	7-10	NONE	N/A	N/A
99	CHNL 32	11	(a)	LM ATTACHED OFF (ON)	N/A
99	CHNL 32	12-15	NONE	N/A	N/A
100	CHNL 33	1-9	NONE	N/A	N/A
100	CHNL 33	10	(a), (h)	BLOCK UPLINK OFF (ON)	N/A
100	CHNL 33	11	(a)	UPLINK TOO FAST OFF (ON)	N/A
100	CHNL 33	12	NONE	N/A	N/A
100	CHNL 33	13	(a)	PIPA FAIL OFF (ON)	N/A
100	CHNL 33	14	(a)	CMC WARNING OFF (ON)	N/A
100	CHNL 33	15	(a)	OSC ALARM OFF (ON)	N/A

TABLE 224A-2 (continued)

Notes:

a) If the bit indicated equals 1, display the word underlined. If the bit indicated equals 0, display the word parenthesis. The "OFF" state replaced by a blank state is also acceptable.

b) If the bit indicated equals 1, set the SGS discrete that displays the word in the display column. If the bit equals 0, remove the appropriate SGS discrete.

c) Display the following:

BIT 4	BIT 5	"XXX" DISPLAY
0	0	OFF
0	1	ZER
1	0	CMC
1	1	MAN

d) Store bit STATUS for G&N 631.

e) Combine the 14 magnitude bits of the most significant part (MS) with 14 magnitude bits of the least significant part (LS). The decimal conversion should be made only after the two parts of the double precision word have been sign checked. The signs appear in bit 15 of each word.

f) Store values of TIME 1, TIME 2 and RANGE TIME for G&N 602.

g) Store bit status for G&N 622A and G&N 632.

h) Store bit status for G&N 631.

i) Treat CDUT as an unsigned 15 bit counter. If $CDUT_8$ is greater than or equal to 61740_8, form $CDUT_8 - 61740_8$, convert to decimal, and multiply by $90°/2^{15}$. Display result as CDUT. If $CDUT_8$ is less than 61740_8, form $CDUT_8 + 16040_8$, convert to decimal and multiply by $90°/2^{15}$. Display result as CDUT.

j) Treat this word as an unsigned 15 Bit counter, convert to decimal and multiply by $360/2^{15}$.

C19) These bits must also be displayed as follows: ISS Mode X_8 X_6 X_5 X_4 X_2 X_1 where Xn is a "0" or "1" for the bit indicated by the subscript.

T_{HRS} - Range time truncated to hrs.

T_{R_1} - Range time

E_p - Present time

Error Exit: None.

Computation Sequence: The following sequence should occur:

(1) A check shall be made after T_{RP}, T_E, and E_P are entered to insure that they are valid. For a valid T_{RP} entry, hrs $\leq$23, min $\leq$59 and sec $\leq$59. For a valid E_P and T_E entry, min $\leq$59 and sec $\leq$59. No check on hrs for E_P and T_E need be made. If an invalid entry occurs, indicate a non-verify on the C-START.

(2) A check shall be made after E_P and T_E is entered to determine if the corresponding GC octal address has been entered. E_P and T_E should be transmitted if its corresponding address was entered. If no address was entered then it should not be transmitted and EPER or TEER should be displayed in the position for 1 2 3 4 of TIME ERROR. If no address was entered for both E_P and T_E, then neither should be transmitted and ADER should be displayed in the position of 1 2 3 4 of TIME ERROR.

(3) When Range Time, T_{R1} is equal to T_{RP} and if the G&N Computer address for Ep is not equal to zero, transmit uplink Ep and the GC address for the time registers using the commands listed under Uplink Commands.

(4) If LOC is not equal to zero, then the quantities T_E and LOC are transmitted uplink using the commands listed under Uplink Commands.

(5) Store the following items for inputs into G&N 602:

T_{R_1} - Range time, which is also equal to T_{RP}

E_p - Present time

T_{HRS} - The value of T_{R_1}, truncated to hours

K - constant to be used in G&N 602

(6) All uplink commands are to be time tagged and filed on the Uplink File Tape.

(7) Before the double precision words E_p and T_E are transmitted uplink they must be converted to double precision words which have a least significant bit of 10 millesecond value.

		Key Code Complement	
1	XXXXX	XXXXX	XXXXX
	5 Bit Keycode		5 Bit Keycode

Figure 601-1

Uplink Requirements:

Transmission to GC: None

DTCS Stimuli Location: Not Applicable

Time of Transmission: Not Applicable

Downlink Requirements:

Measurement ID: Measurement No. G 0001V

Tolerance:

If program fails Δt test, indicate failure by display indicated under TEST in "Computations" section and return to Uplink Control Program.

Failure of program to execute because of no GC time available should be indicated by "TIME ERROR 4" and exit should be made to Uplink Control Program.

The accuracy of Δt is to be 10 milliseconds.

Filing Requirements:

During System Tests a recording of T_{R_1}, T_{R_2}, E_P, T_A, K, $T_{R_{HRS}}$, $T_{R_{2(HRS)}}$ and DCNT should be made.

Remarks:

Definition of terms used in this subprogram are as follows:

T_{R_1} - Range time from G&N 601 in hrs, mins, secs, ms.

T_{HRS} - Range time from G&N 601 truncated to hrs.

K = Transmission delays from G&N 601 in ms.

E_P = Preset Time insert in LGC clock from G&N 601, in hrs, mins, secs, ms.

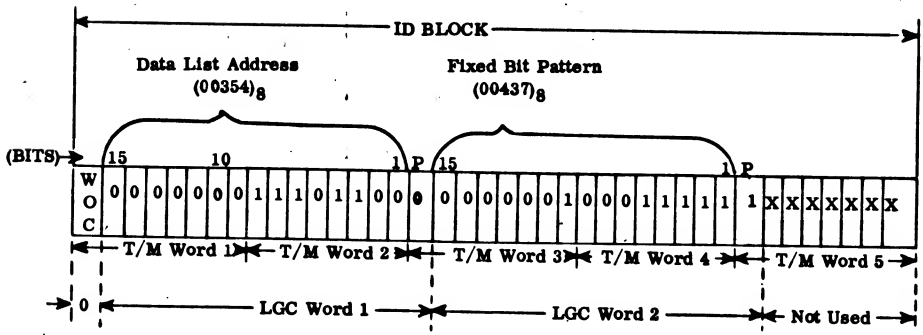
T_A - GC time from G&N 224 or G&N 624 in hrs, mins, secs, ms.

T_{R_2} - Range time of GC time receipt in hrs, mins, secs, ms.

WORD 4	8	7	6	5	4	3	2	1
WORD 5	P	X	X	X	X	X	X	X

Where WOC = Word order code (1-bit)
P = Parity (LGC word has odd parity)
X = Not used

The ID block should normally appear once every 100 prime frames and contains a zero WOC, two LGC 16-bit words including parity bits (P) and seven unused bit positions (X). LGC word 1 contains the data list address in bit positions 15-1 and parity (P) in bit position zero. LGC Word 2 contains a fixed bit pattern sync word $(00437)_8$ in bit positions 1-15 and Parity (P) in bit position zero. LGC Word 1 precedes LGC Word 2 in the data block transmission. The word order code (WOC) bit contains a 0 for all LGC ID blocks. An example block and word formats is shown below.



The following ID groups shall be accepted as valid:

Downlist No.	(ID Word)8	(SYNC Word)8	Table No.
1	00236	00437	621-200-1

The data blocks (normally 99 between ID blocks) contain a WOC, two LGC 16-bit words including parity bits (P) and seven unused bit positions (X).

LGC Word 1 precedes LGC Word 2 in the data block transmission. The word order code (WOC) bit contains a 1 for all LGC Data Blocks. The block and word formats are specified as follows:

621-200.2

TABLE 621-200-1

DOWNLIST NO. 1

BLOCK	WRD CNT	LGC WRD 1	WRD CNT	LGC WRD 2	WOC
1	1	DOWNLIST ID (00236-octal)	2	SYNC BITS (00437-OCTAL)	0
2	3	STATE VEC X POS MSB AVE-G	4	STATE VEC X POS LSB AVE-G	1
3	5	STATE VEC Y POS MSB AVE-G	6	STATE VEC Y POS LSB AVE-G	1
4	7	STATE VEC Z POS MSB AVE-G	8	STATE VEC Z POS LSB AVE-G	1
5	9	STATE VEC X VEL MSB AVE-G	10	STATE VEC X VEL LSB AVE-G	1
6	11	STATE VEC Y VEL MSB AVE-G	12	STATE VEC Y VEL LSB AVE-G	1
7	13	STATE VEC Z VEL MSB AVE-G	14	STATE VEC Z VEL LSB AVE-G	1
8	15	STATIME MSB	16	STATIME LSB	1
9	17	GARBAGE	18	DESIRED CDU X	1
10	19	DESIRED CDUY	20	DESIRED CDU Z	1
11	21	DELV X MSB	22	DELV X LSB	1
12	23	DELV Y MSB	24	DELV Y LSB	1
13	25	DELV Z MSB	26	DELV Z LSB	1
14	27	LMP CMD	28	LMP CMD+1	1
15	29	LMP CMD+2	30	LMP CMD+3	1
16	31	LMP CMD+4	32	LMP CMD+5	1
17	33	LMP CMD+6	34	LMP CMD+7	1
18	35	LMP IN	36	LMP OUT	1
19	37	SPARE	38	SPARE	1
20	39	UPVERB	40	COMPNUMB	1
21	41	STATE COUNT	42	UPOLDMOD	1
22	43	ST BUFF +0	44	ST BUFF +1	1
23	45	ST BUFF +2	46	ST BUFF +3	1
24	47	ST BUFF +4	48	ST BUFF +5	1
25	49	ST BUFF +6	50	ST BUFF +7	1
26	51	ST BUFF +8D	52	ST BUFF +9D	1
27	53	ST BUFF +10D	54	ST BUFF +11D	1
28	55	ST BUFF +12D	56	ST BUFF +13D	1
29	57	I MODE 30	58	I MODE 33	1
30	59	TIME OF EVENT MSB	60	TIME OF EVENT LSB	1
31	61	FC MSB	62	FC LSB	1
32	63	AOSQ	64	AOSR	1
33	65	TIGN MSB	66	TIGN LSB	1
34	67	REDO COUNTER	68	S FAIL	1
35	69	GARBAGE	70	ACTUAL CDU X	1
36	71	ACTUAL CDU Y	72	ACTUAL CDU Z	1
37	73	OMEGA P	74	OMEGA Q	1
38	75	GARBAGE	76	OMEGA R	1
39	77	STATE	78	FLAGWORD 1	1
40	79	FLAGWORD 2	80	DAP BOOLS	1
41	81	CHANNEL 11	82	CHANNEL 12	1

TABLE 624A-8 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION See Note ()	DISPLAY	SCALE FACTOR
99	CHNL 32	4	(a)	JETS 6-7 FAIL OFF (ON)	N/A
99	"	5	"	JETS 14-16 FAIL OFF (ON)	"
99	"	6	"	JETS 13-15 FAIL OFF (ON)	"
99	"	7	"	JETS 9-12 FAIL OFF (ON)	"
99	"	8	"	JETS 10-11 FAIL OFF (ON)	"
99	"	9	"	PITCH GIM OFF (ON)	"
99	"	10	"	ROLL GIM OFF (ON)	"
99	"	11-15	None	N/A	"
100	CHNL 33	1	None	N/A	"
100	"	2	(a)	RR ON/AUTO OFF (ON)	"
100	"	3	"	RR RANGE LO-SC OFF (ON)	"
100	"	4	"	RR DATA GOOD OFF (ON)	"
100	"	5	"	LR ALT D GOOD OFF (ON)	"
100	"	6	"	LR POS 1 OFF (ON)	"
100	"	7	"	LR POS 2 OFF (ON)	"
100	"	8	"	LR VEL D GOOD OFF (ON)	"
100	"	9	"	LR ALT LO-SC OFF (ON)	"
100	"	10	(j)	N/A	"
100	"	11	"	UPLINK TOO FAST OFF (ON)	"
100	"	12	None	N/A	"
100	"	13	"	PIPA FAIL OFF (ON)	"
100	"	14	"	LGC WARNING OFF (ON)	"
100	"	15	"	OSC ALARM OFF (ON)	"

TABLE 624A-1 (Continued)

NOTES:

N/A - Not Applicable.

(a) - If the bit indicated equals one, display the word underlined. If the bit indicated equals zero, display the word in parentheses.

(b) - If either bit equals one, display the word underlined. If both bits are zero, display the word in parentheses.

(c) - Combine the 14 magnitude bits of the most significant (MS) part with 14 magnitude bits of the least significant part(LS). The decimal conversion should be made only after the two parts of the double precision word have been sign checked. The signs appear in bit 15 of each word. See "Remarks" for a method for handling double precision words.

(d) - Same as (b).

(e) - NOTE: This double precision word must be scaled two ways each of which is displayed.

(f) - Store bit status for G&N 631.

(g) - Store values for G&N 602.

(h) - Store bit status for G&N 622 and 632. If the indicated bit is a one, set the SGS Discrete for VERB-NOUN FLASH. If the bit is zero, clear the discrete.

(i) - If the bit indicated equals one, set the SGS Discrete that displays the word in the display column. If the bit equals zero, remove the appropriate SGS Discrete.

(j) - Store bit status for G&N 631. If the bit indicated equals one, Block Uplink is "ON"; if the bit indicated equals zero, Block Uplink is "OFF".

TABLE 624B-1 (Continued)

WORD NUMBER	WORD NAME	BIT (S)	DATA MANIPULATION See Note ()	DISPLAY
21	ALTSAVE (MS)	1-15	} (c) SF = 2.345 FT	ALT SAVE ±XXXXXXXXX.XXX FT
22	ALTSAVE + 1 (LS)	1-15		
23	FINALT (MS)	1-15	} (c) SF = 2.345 FT	FIN ALT ±XXXXXXXXX.XXX FT
24	FINALT + 1 (LS)	1-15		
25	FORVEL	1-15	CTDEC SF = 0.5571 FPS	FORVEL ±XXX.XX FPS
26	LATVEL	1-15	CTDEC SF = 0.5571 FPS	LATVEL ±XXX.XX FPS
27	CDUX	1-15	(k)	CDUX XXX.XX DEG
28	CDUY	1-15	(k)	CDUY XXX.XX DEG
29	CDUZ	1-15	(k)	CDUZ XXX.XX DEG
30	OPTY	1-15	None	N/A
31	RR TRUN	1-15	(k)	RR TRUN XXX.XX DEG
32	RR SHAFT	1-15	(k)	RR SHAFT XXX.XX DEG
33	STATE	1-15	None	N/A
34	STATE + 1	1-15	None	N/A
35	STATE + 2	1-15	None	N/A
36	STATE + 3	1-15	None	N/A
37	REDO CTR	1-15	CTDEC SF = 1	REDO CTR ±XXXXX
38	FAIL REG	1-15	CTOCT	FAIL REG XXXXX
39	LMPCMD	1-15	CTOCT	LMPCMD XXXXX
40	IMODES30	1	(a)	IGN PIP FAIL ON ()
40	IMODES30	2	None	N/A
40	IMODES30	3	(a)	IGN I-CDU FAIL ON ()
40	IMODES30	4	(a)	IGN IMU FAIL ON ()
40	IMODES30	6	(a)	INITIALIZE ISS ON ()
40	IMODES30	7-15	None	N/A
41	LAST Y CMD	1-15	None	N/A
42	LAST X CMD	1-15	None	N/A
43	TANG	1-15	None	N/A
44	TANG + 1	1-15	None	N/A
45	THETAD	1-15	None	N/A

TABLE 624B-1 (Continued)

WORD NUMBER	WORD NAME	BIT (S)	DATA MANIPULATION See Note ()	DISPLAY
46	THETAD + 1	1-15	None	N/A
47	THETAD + 2	1-15	None	N/A
48	DELVX	1-15	None	N/A
49	MARKSTAT	1-15	None	N/A
50	XY MARK	1-15	None	N/A
51	DRIFT 0	1-15	CTDEC SF = $1000/2^{14}$ MERU	VDRIFT 0 ±XXX.XX MERU
52	DRIFT 0 + 1	1-15	None	N/A
53	DRIFT 1	1-15	CTDEC SF = $1000/2^{14}$ MERU	SDRIFT I ±XXX.XX MERU
54	DRIFT 1 + 1	1-15	None	N/A
55	DRIFT 2	1-15	CTDEC SF = $1000/2^{14}$ MERU	EDRIFT T ±XXX.XX MERU
56	DRIFT 2 + 1	1-15	None	N/A
57	TORQUE 0	1-15	None	N/A
58	TORQUE + 1	1-15	None	N/A
59	ANG Z	1-15	CTDEC SF = 1	ANG Z ±XXXXX
60	ANG Z + 1	1-15	None	N/A
61	ANG Y/PIPA N	1-15	CTOCT	ANG Y/PIPA N XXXXX
62	ANG Y + 1	1-15	None	N/A
63	ANG X/PIPA E	1-15	CTOCT	ANG X/PIPA E XXXXX
64	ANG X + 1	1-15	None	N/A
65	V LAUN	1-15	None	N/A
66	V LAUN + 1	1-15	None	N/A
67	V LAUN + 4	1-15	None	N/A
68	V LAUN + 5	1-15	None	N/A
69	R STACK (MS)	1-15	(c), (e) SF = +9.38 FT	RR RANGE ±XXXXXXXXXX.XX FT
70	R STACK + 1 (LS)	1-15	(c), (e) SF = +0.6435 FPS	LR VX ±XXXXXXXXX.XXXX FPS
71	R STACK + 6 (MS)	1-15	(c), (e) SF = +0.6278 FPS	RR RANGE RATE ±XXXXXXXXX.XXXX FPS
72	R STACK + 7 (LS)	1-15	(c), (e) SF = +1.2525 FPS	LR VY ±XXXXXXXXX.XXXX FPS
73	R STACK +12D (MS)	1-15	(c) SF = +0.8571 FPS	LR VZ ±XXXXXXXXX.XXXX FPS
74	R STACK +13D (LS)	1-15		
75	R STACK +18D (MS)	1-15	(c) SF = +1.079 FT	LR ALT ±XXXXXXXXX.XXX FT
76	R STACK +19D (LS)	1-15		

TABLE 624B-1 (CONTINUED)

WORD NUMBER	WORD NAME	BIT (S)	DATA MANIPULATION See Note ()	DISPLAY
99	CHNL 32	1	(a)	JETS 2-4 FAIL _____ (ON)
99	CHNL 32	2	(a)	JETS 5-8 FAIL _____ (ON)
99	CHNL 32	3	(a)	JETS 1-3 FAIL _____ (ON)
99	CHNL 32	4	(a)	JETS 6-7 FAIL _____ (ON)
99	CHNL 32	5	(a)	JETS 14-16 FAIL _____ (ON)
99	CHNL 32	6	(a)	JETS 13-15 FAIL _____ (ON)
99	CHNL 32	7	(a)	JETS 9-12 FAIL _____ (ON)
99	CHNL 32	8	(a)	JETS 10-11 FAIL _____ (ON)
99	CHNL 32	9	(a)	GIM OFF _____ (ON)
99	CHNL 32	10	(a)	APP GIM FAIL _____ (ON)
99	CHNL 32	11-15	None	N/A
100	CHNL 33	1	None	N/A
100	CHNL 33	2	(a)	RR ON/AUTO _____ (ON)
100	CHNL 33	3	(a)	RR RANGE LO-SC _____ (ON)
100	CHNL 33	4	(a)	RR DATA GOOD _____ (ON)
100	CHNL 33	5	(a)	LR ALT D GOOD _____ (ON)
100	CHNL 33	6	(a)	LR POS 1 _____ (ON)
100	CHNL 33	7	(a)	LR POS 2 _____ (ON)
100	CHNL 33	8	(a)	LR VEL D GOOD _____ (ON)
100	CHNL 33	9	(a)	LR ALT LO-SC _____ (ON)
100	CHNL 33	10	(1)	N/A
100	CHNL 33	11	(a)	UPLINK TOO FAST _____ (ON)
100	CHNL 33	12	N/A	N/A
100	CHNL 33	13	(a)	PIPA FAIL _____ (ON)
100	CHNL 33	14	(a)	LGC WARNING _____ (ON)
100	CHNL 33	15	(a)	OSC ALARM _____ (ON)

TABLE 624B-1 (Continued)

NOTES:

N/A	Not Applicable
CTDEC	Convert the word to decimal considering the word to be a 14 bit number with a sign bit in bit 15 and that if the sign is negative (bit 15 = 1) the 14 data bits are received as the 2's complement.
CTOCT	Convert the 15 bit number to OCTAL
SF	After converting the number to decimal, multiply by the scale factor indicated.
(a)	If the bit indicated equals one, display the word underlined. If the bit indicated equals zero, display the word in parentheses.
(c)	Combine the 14 magnitude bits of the most significant (MS) part with 14 magnitude bits of the least significant part (LS). The decimal conversion should be made only after the two parts of the double precision word have been sign checked. The signs appear in bit 15 of each word. See "Remarks" for a method for handling double precision words.
(e)	NOTE: This double precision word must be scaled two ways, each of which is displayed.
(f)	Store bit status for G&N 631.
(g)	Store values for G&N 602
(h)	Store bit status for G&N 622 and 632. If the indicated bit is a one, set the SGS Discrete for VERB-NOUN FLASH. If the bit is zero, clear the discrete.
(i)	If the bit indicated equals one, set the SGS Discrete that displays the word in the display column. If the bit equals zero, remove the appropriate SGS Discrete.
(j)	These bits must also be displayed as follows: ISS MODE $\underline{X_8}\ \underline{X_6}\ \underline{X_5}\ \underline{X_4}\ \underline{X_2}\ \underline{X_1}$ where X_n is a '0' or '1' for the bit indicated by the subscript.
(k)	Treat this word as an unsigned 15 bit counter, convert to decimal and multiply by $360°/2^{15}$
(l)	Store bit status for G&N 631. If the bit indicated equals one, Block Uplink is "ON", if the bit indicated equals zero, Block Uplink is "OFF".

TABLE 624-200-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION			DISPLAY
			Code*	Scale Factor	See Note ()	
86, 186	CHANNEL 31	15	C2, C20			ATT CONT DET——(ON)
87, 187	CHANNEL 32	1	C2, C20			JETS 2-4 FAIL——(ON)
87, 187	CHANNEL 32	2	C2, C20			JETS 5-8 FAIL——(ON)
87, 187	CHANNEL 32	3	C2, C20			JETS 1-3 FAIL——(ON)
87, 187	CHANNEL 32	4	C2, C20			JETS 6-7 FAIL——(ON)
87, 187	CHANNEL 32	5	C2, C20			JETS 14-16 FL——(ON)
87, 187	CHANNEL 32	6	C2, C20			JETS 13-15 FL——(ON)
87, 187	CHANNEL 32	7	C2, C20			JETS 9-12 FL——(ON)
87, 187	CHANNEL 32	8	C2, C20			JETS 10-11 FL——(ON)
87, 187	CHANNEL 32	9	C2, C20			GIMB OFF——(ON)
87, 187	CHANNEL 32	10	C2, C20			APP GIMB FAIL——(ON)
87, 187	CHANNEL 32	11-15	C20			N/A
88, 188	CHANNEL 33	1	C20			N/A
88, 188	CHANNEL 33	2	C2, C20			RR ON/AUTO——(ON)
88, 188	CHANNEL 33	3	C2, C20			RR RANGE LO-SC—(ON)
88, 188	CHANNEL 33	4	C2, C20			RR DATA GOOD——(ON)
88, 188	CHANNEL 33	5	C2, C20			LR ALT D OK——(ON)
88, 188	CHANNEL 33	6	C2, C20			LR POS 1——(ON)
88, 188	CHANNEL 33	7	C2, C20			LR POS 2——(ON)
88, 188	CHANNEL 33	8	C2, C20			LR VEL D OK——(ON)
88, 188	CHANNEL 33	9	C2, C20			LR ALT LO-SC——(ON)
88, 188	CHANNEL 33	10	C2,C25 C20			N/A
88, 188	CHANNEL 33	11	C2, C20			UPLINK FAST——(ON)

* Refer to Table 624-200-2.

TABLE 624-200-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION			DISPLAY
			Code*	Scale Factor	See Note ()	
103	COMPTORK	1-15	C4,			COMPTORK ±XXXXX
104	COMPTORK +1	1-15	C5	$1/2^7$		
105	COMPTORK +2	1-15	C4,			±XXXXX
106	COMPTORK +3	1-15	C5	$1/2^7$		
107	COMPTORK +4	1-15	C4,			±XXXXXGPLS
108	COMPTORK +5	1-15	C5	$1/2^7$		
109	FAILREG	1-15	N/A			N/A
110	FAIL REG +1	1-15	N/A			N/A
111	FAILREG +2	1-15	N/A			N/A
112	ALMCADR	1-15	N/A			N/A
113	ALMCADR +1	1-15	N/A			N/A
114	ERCOUNT	1-15	N/A			N/A
115	PIPA X	1-15	C7			PIPA CTR ±XXXXX
116	PIPA Y	1-15	C7			±XXXXX
117	PIPA Z	1-15	C7			±XXXXX
118						
119	STATE +4	1-4	C20			N/A
119	STATE +4	5	C1, C20			IGN DELAY ON ()
119	STATE +4	6	C1, C20			RCO NOT CNTRLD ON ()
119	STATE +4	7	C1, C20			EXT TRGT SETUP ON ()
119	STATE +4	8	C1, C20			LAMB TRGT ON ()
119	STATE +4	9	C1, C20			TGO EST ON ()
119	STATE +4	10	C20			N/A
119	STATE +4	11	C1, C20			TRF ANG GT 180 ON ()
119	STATE +4	12	C1, C20			GUESS AVAIL ON ()
119	STATE +4	13	C1, C20			1st LAMB I ON ()
119	STATE +4	14	C1, C20			LAMB COMP ON ()
119	STATE +4	15	C1, C20			LAMB RTN NCON ON ()
120						

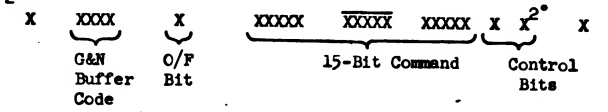
* Refer to Table 624-200-2.

TABLE 624-200-2 (Continued)

GENERAL NAME	SUGGESTED CODE	DESCRIPTION
WORD 85 and 185	C23	Bit 9 is saved for G/N 631, then processed as a regular event.
WORD 101 and 102	C17	Store values for G&N 602.
WORD 82 and 182	C19	These bits must also be displayed as follows: ISS MODE X_8 X_6 X_5 X_4 X_2 X_1 where X_n is a "0" or "1" for the bit indicated by the subscript.
FILE CODE	C20	File with time tag.
WORD 88 AND 188	C25	Bit 10 is saved for G&N 631.

and required control bits as shown below.

G&N UPLINK WORD FORMAT



Prior to transmittal of a sequence of command words, a check is made on the GC discrete "BLOCK UPLINK". If this discrete is "ON", then a non-verify display will occur on the K-START, the keycode will not be transmitted and a normal system recording will occur on the command tape as specified in Table 631-1.

If UPLINK is not BLOCKED, a sequence of tests are made on the incoming keycodes to determine if the command sequence contains a V36. If so, two GC discretes are monitored, namely the "Gimbal Lock" and the "IMU Operate". If both discretes are set to a "ON" state, then a "non-verify" display will occur on the K-START and the next keycode will not be transmitted Uplink. Another discrete is monitored, the "Operator Error" flashing discrete. An error status will cause this subprogram to terminate the processing of GC commands by inhibiting further K-START data entry with a "non-verify" signal. A normal system recording will occur on the command tape as specified in Table 631-1.

The final discrete tested is UPLOCK, A "ON" state will result in a test for an "alarm reset" keycode. If this code is available, then two commands will be transmitted at the correct frequency. The first command will zero the GC Uplink register and the second, namely, the "reset" keycode will possibly reset the alarm indication triggered by UPLOCK. The "OFF" state for this discrete, will allow the subprogram to continue and transmit the commands to the GC with subsequent recordings on the command tape.

The K-START module is sealed after receipt of a keycode to allow the correct transmission frequency to the GC to be utilized. The sealing can occur as soon as a "good" CSR is received from the DTCS, after which a time delay is utilized to give an approximate maximum input rate to the GC of six keycodes / sec.

A "bad" CSR response should cause the K-START to display a "non-verify" and subsequently be unsealed, to allow further operator action to be taken. It should be

noted at this point, that as the state of the above mentioned discretes can change at a maximum of only once every second, approximately eight commands could be transmitted Uplink before repeating discrete testing. Figure 631-1 is given as a representative flow, to convey the intent of the subprogram operation.

Operator Action:

During the processing of the input keycodes a test is made to determine whether the range time since "Sealing" the K-START module is greater than or equal to the time delay factor entered via C-START. If so, the verify indication is displayed and the subprogram then transfers control to the Uplink Executive program. If not, the module remains "Sealed" to inhibit further input through the K-START module until the time delay has elapsed. This regulates the input rate of keycodes to the GC. A nominal time delay factor is 90 milliseconds.

Console Operator: Operator action is required to initiate this sub-program by entering data via the K-START module keyboard or tape reader.

When a NON-VERIFY display occurs, further character entry is allowed after depression of the NON-VERIFY switch.

For tape mode of operation enter 3100000XXX into C-START. XXX is the time delay factor in milliseconds.

The operator's responsibility includes the monitoring of displays and the initiation of procedures based upon the display interpretation. Normally the status of the "BLOCK UPLINK" CRT display should be reviewed by the operator prior to insertion of data through the K-START module. However, this K-START subprogram will monitor this discrete, and inhibit any data transfer if this discrete gives an "ON" condition. The "non-verify" display which occurs under this condition will then be reset by the operator. If the "Operator Error On" condition appears, this subprogram will inhibit data transfer through the K-START with a non-verify. The operator will reset this "non-verify" switch and insert a "reset" keycode to clear the "Operator Error" display. Then correct the illegal data sequence and re-enter through the K-START.

An "UPLOCK" display will again inhibit data transfer through the K-START. The operator will reset the "non-verify" and insert a "reset" keycode to clear the discrete. The subprogram will then transmit a "zero" message followed by the "reset" keycode. This may reset the "UPLOCK" discrete and the operator can continue his interrupted sequence of commands by re-inserting the previous keycode.

Two other conditions cause this subprogram to inhibit data input through the K-START, they are a parity error and an invalid keycode. The operator will release the non-verify and apply corrective measures to the input.

If a "Keyerr 2" CRT display occurs, then the operator should re-insert the "Verb 36 Enter" sequence after monitoring the "Gimbal Lock" and "IMU Operate" discrete displays.

Commands inserted via the keyboard will be verified by means of the "closed loop" display, which depicts the GC DSKY status on the CRT, prior to depression of the "Enter" keycodes. The punched tape input, if visual verification is desired, should contain strategically located "stop" codes in the Verb/Noun and parameter sequences, to allow the operator time to perform verification.

Spacecraft Operator: No activity required.

Uplink Requirements:

DTCS Transmission: The data word transmitted to the G&N buffer is identified in the Computation Sequence and will be generated as required.

DTCS Stimuli: None

Transmission Time: During G&N testing this will be specified in the Operational Checkout Procedure. All other times will be as required.

Filing: 1) All K-START command information will be recorded on the command tape.

2) Additional recordings for error conditions and discrete inhibits are specified in Table 631-1.

Downlink Requirements: CRT Displays:

1. The time delay factor in XXX milliseconds and the appropriate nomenclature.

2. Program error displays as specified in Table 631-1.

The Program Requirements Process Specification contains the CRT page and line information.

Remarks: Definition of Flow Chart Symbols

Symbol	Definition
KEYWORD	Contains current keycode to be processed.
ZERCODE	Uplink command to zero the LGC Inlink register for resync purposes.
UPCOM	Contains command word content.
Channel 30 Channel 11 UPLOCK DSPTAB +11	GC Discrete registers, processed by G&N 224A, 624A, 624B or 624-200.

Table 631-1

CRT Error Display Definition

Error or Discrete	CRT Display	K-START Module Display	Command Tape Edit
Odd parity does not exist in the data frame received from K-START module.	PARERR 1	Non-Verify	631, PARERR 1, Time Ref.
An invalid GC keycode has been received by this sub-program.	KEYERR 1	Non-Verify	631, KEYERR 1, Time Ref.
An illegal entry of a V36E has occured.	KEYERR 2	Non-Verify	631, KEYERR 2, Time Ref.
No keycodes can be received by the GC via Uplink, therefore further keycode entry through the K-START is inhibited.	BLOCK UPLINK ON*	Non-Verify	631, Block Uplink Time Ref.
This indicates than an incorrect keycode loading procedure has occured and entry through the K-START is inhibited.	OPERATOR ERROR ON*	Non-Verify	631, Op. Error, Time Ref.

*These CRT discrete displays are set by G&N 224A, 624A, 624B or 624-200 ACE-S/C Downlink Interpretation Program.

Title: Downlink Format and Interpretation Subprogram G&N 721

Part Of: Downlink Program

Purpose: The subprogram accepts each block of five 8-bit G&N T/M words (G&N Computer Data), reformats the block into two 16-bit G&N Computer words and checks parity. A check for the correct data sequence and a valid ID Block is also made. After these checks, the 16-bit words are available for interpretation as defined on the Downlink Requirements Cards or routed to subprogram G&N 722 for further processing. If any of the checks fail, an error flag is set.

Calling Sequence:

Entry: This subprogram operates under Downlink Executive Program Control and is initiated upon receipt of an Executive Program interrupt.

Data:

Input:
(a) A sequence of five 8-bit G&N T/M words (one block) is received each prime frame. The number of blocks for each downlist and the content of each block will be specified on the Downlink Requirements Cards. The first block in a downlist will be the ID block which identifies which downlist is to be processed.

(b) Notification upon loss of a block (Prime Frame).

Output:
(a) Valid data is available for interpretation as specified on the Downlink Requirements Cards or transmitted to ACE-S/C Subprogram G&N 722 for further processing and display.

(b) Error conditions will be displayed and recorded.

Normal Exit: Return to Executive Program Control.

Error Exit: None.

Computation Sequence:

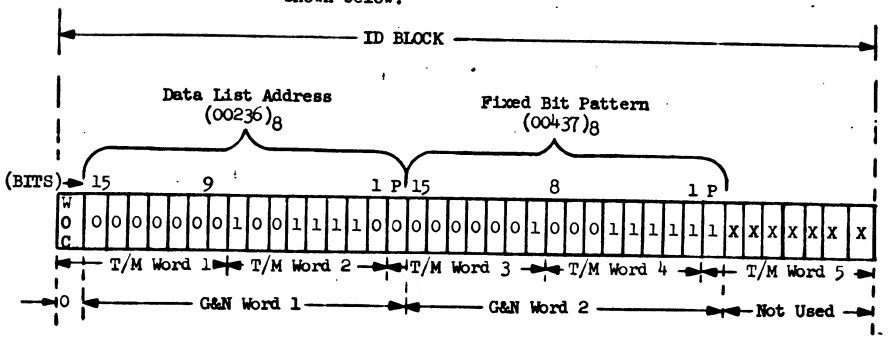
General: The program receives blocks of five 8-bit T/M words, with the following configuration:

WORD 1	WOC	15	14	13	12	11	10	9
WORD 2	8	7	6	5	4	3	2	1
WORD 3	P	15	14	13	12	11	10	9
WORD 4	8	7	6	5	4	3	2	1
WORD 5	P	X	X	X	X	X	X	X

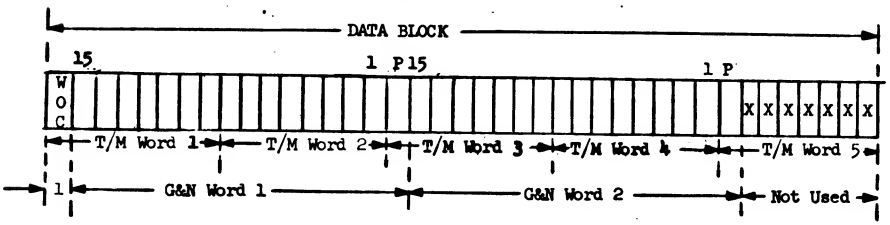
Where WOC = Word order code (1-bit)
P = Parity (G&N words have odd parity)
X = Not used

The ID block contains a zero WOC, two 16-bit words including parity bits (P) and seven unused bit positions (X). Word 1 contains the data list address in bit positions 15-1 and parity (P) in bit position zero.

Word 2 contains a fixed bit pattern sync word $(00437)_8$ in positions 15-1 and Parity (P) in bit position zero. Word 1 precedes Word 2 in the data block transmission. The word order code (WOC) bit contains a 0 for all ID blocks. An example of the ID block and word format is shown below:



The data blocks contain a WOC, two 16-bit words including parity bits (P) and seven unused bit positions (X). Word 1 precedes Word 2 in the data block transmission. The word order code (WOC) bit contains a 1 for all Data Blocks. An example of the Data Block and word format is shown below:



The G&N Computer downlist content is specified on the Downlink Requirements Cards referenced by the ID word. The position of the G&N Computer word in each fixed length list determines whether the word is to be used for data monitoring and processing or sent to G&N 722 for DSKY display monitoring.

Logic Sequence:

1. Upon initial entry, for a decommutator "loss of sync" or under conditions as specified in steps 3 and 4 below, wait for an ID block which has a word order code of 0 then initialize a word counter. If no requirement for this step, proceed to step 2.

2. Under normal conditions or successful completion of step 1 above, check parity of both the 1st and 2nd G&N Computer words of the block. If this check fails, display WORDERR 1 and file WORDERR 1 with the information defined under filing requirements. Proceed to step 3.

3. For a WOC = 0, perform ID check for:

 a. Correct data list address in bits 1-15 of 1st word in the ID block.

 b. $(00437)_8$ in bits 1-15 of the 2nd word in the ID block.

If either of the above checks fail, display WORDERR 2 and file WORDERR 2 with information defined under filing requirements. Return to wait routine specified in step 1 above.

If ID check passes, check that an ID block has not been received too soon.

If it has been received too soon, display SYNCERR 2 and file SYNCERR 2 with the information defined under filing requirements and proceed as if it had been in the correct sequence. If the ID block is received in the correct sequence, initialize the word count for processing data blocks and return to Exec. program control.

4. For a WOC $\neq$ 0, use word count to determine if an ID was expected. If it was, display SYNCERR 1 and file SYNCERR 1 with the information defined under Filing Requirements. Return to 'wait routine' specified in step 1 above. If no ID block was expected, proceed to step 5.

5. DSPTAB words +0 thru +10D are to be sent to G&N 722 along with the identifier after taking the ones complement of the DSPTAB word if bit 15 is a one (1). All other words are to be processed per the Downlink Requirements Cards.

6. When G&N Computer power is off, all bits in the T/M word blocks will be zero causing a constant WORDERR 1 and 2 display. If this condition exists, the error should be filed only once per minute.

7. When the G&N Computer is in STANDBY, all the bits in the T/M word blocks will be ONES, causing a constant WORDERR 1 and SYNCERR 1 display. If this condition exists, the error should be filed once per minute.

Downlink Requirements:

Measurement ID: Specified on the Downlink Requirements Cards.

Display: This information is detailed in the computational sequence description and consists of program error displays as specified in Table 721-1. The Downlink Requirements cards shall contain the display requirements.

Filing: Upon detection of an error, the appropriate information is recorded on the file tape as specified in Table 721-1.

TABLE 721-1

ERROR DESCRIPTION	DISPLAY	FILE TAPE
This indicates that Word count has incremented beyond a specified limit, with no ID word detected.	SYNCERR 1	SYNCERR 1, Time Tag reference, Word Count, ID block.
At this point Word Count has not reached its specified limit, but an ID block has been received.	SYNCERR 2	SYNCERR 2, Time Tag Reference Word count, ID block.
Parity is incorrect in the 1st or 2nd G&N Computer word of either an ID Block or a Data Block.	WORDERR 1	WORDERR 1, Time Tag Reference, Block count, ID or Data Block containing the parity error.
The content of the ID block is not correct.	WORDERR 2	WORDERR 2, Time Tag Reference, Word count ID Block.

Title: Display Program (DSPTAB) G&N 722

Part of: Downlink Program

Purpose: The Display Program interprets all DSPTAB words that are detected as such by the Downlink Format Program and generates displays identical in content and format to the on-board spacecraft DSKY displays. This program provides ACE-S/C ground station test personnel the capability of continuously monitoring all spacecraft keyboard displays.

Calling Sequence:

Entry: This program is activated only by the Downlink Format Program whenever program display words are to be interpreted.

Data: Input: Inputs to the Display Program shall consist of a complete 16-bit Downlink DSPTAB word and identifier.

Output: Coded information to be displayed.

Normal Exit: Return to the ACE Executive Program.

Error Exit: Error conditions shall cause error information to be displayed and recorded on the file tape. After error recording, control is returned to the ACE Executive Program. Error messages are detailed in Table 722-3.

Computation Sequence: Activation of the Display Program is attained via the Downlink Format Program. Inputs to this program will be the 16-bit Downlink word and an identifier. The identifier specifies which DSPTAB word in the Downlink list is to be processed.

The 16-bit Downlink DSPTAB word consists of four parts of coded information plus a parity bit. The four parts are:

1. Bits 15-12: The address in these bits is not used.

2. Bit 11: The special code in this bit specifies a particular discrete associated with the DSPTAB word.

3. Bits 10-6: Represent Display Codes which are associated with specific Display Names. These codes specify the numeric character to be displayed in accordance with Table 722-2.

4. Bits 5-1: Same as bits 10-6 above.

Since the contents of the DSPTAB table is sequentially transmitted Downlink, the Downlink Format Program shall supply this subprogram with the DSPTAB contents (display word) and identifier. The display word associated with each DSPTAB is defined in Table 722-1.

Upon entry from the Downlink Format Program, the display program shall check the identifier to determine which of the 11 DSPTAB words has been received.

The Logic sequence for the DSPTAB Words depends on the state of bit 11. Below is a brief description of the action to be taken.

DSPTAB	DSPTAB WORD ACTION
+2, +8, +9D or +10D	The special code bit (bit 11), of these 4 DSPTAB words, is not applicable, therefore perform sequence 1 as described below.
+7	Bit 11 is not applicable, therefore perform sequence 2 as described below.
+1, +4, or +6	Bit 11 of these DSPTAB words is interpreted as follows: Bit 11 = 1, Set sign indicator of R to plus. Bit 11 = 0, do not change the sign indicator of R. Perform sequence 1 as described below.
+0, +3 or +5	Bit 11 of these DSPTAB words is interpreted as follows: Bit 11 = 1, set sign indicator of R to minus. Bit 11 = 0, set sign indicator of R to blank. Perform sequence 1 as described below.

NOTE: With DSPTAB +5 and +6 set the sign of R1;
DSPTAB +3 and +4 set the sign of R2;
DSPTAB +0 and +1 set the sign of R3.

Sequence 1 - extracts the relay code corresponding to bits 10-6 of the Downlink word and checks it against Table 722-2 for legality. If the code is legal the indicator is set to display the digit from Table 722-2 followed by a transfer to sequence 2. If the code is not legal clear the sign display indicator and initiate a relay-error exit. (See Table 722-3)

Sequence 2 - extracts the relay code corresponding to bits 5-1 and checks it against Table 722-2 for legality. If the code is legal the indicator is set to display the digit from Table 722-2 followed by a return to the ACE Executive Program. If the code is not legal, clear the sign and first digit display indicators and initiate a relay-error exit. (See Table 722-3)

Option - at the option of the operator an R-START may be used to transcribe the entire display on to the file tape. This R-START will be interrogated after the processing of the 11th display word. If the R-START is selected and the CRT display has changed since the last recording, the entire display is to be recorded (including FLASH and UPLINK indicators). If either the R-START is not selected or the display has not changed, no recording should be made. The recording should be prefaced by 722 Display Recording.

Operator Action:

Console Operator: The operator shall have the option of transcribing the entire display on file tape by use of an R-START as explained under "option" of the "Computation sequence".

Downlink Requirements:

Display: Display the results of the "computation sequence" sequence 1 and 2.

Filing: The results of this subprogram shall be filed as explained in the "computation sequence".

TABLE 722-1

TABLE OF DISPLAY WORDS

DSPTAB	Address Bits 15-12 Binary Code	Special Code Bit 11	Display Name Relay Code for Bits 10-6	Display Name Relay Code for Bits 5-1
+10D	N	- -	MD1	MD2
+ 9D	O	- -	VD1	VD2
+ 8D	T	- -	ND1	ND2
+ 7		- -	- -	R1D1
+ 6	U	+R1	R1D2	R1D3
+ 5	S	-R1	R1D4	R1D5
+ 4	E	+R2	R2D1	R2D2
+ 3	D	-R2	R2D3	R2D4
+ 2		- -	R2D5	R3D1
+ 1		+R3	R3D2	R3D3
+ 0		-R3	R3D4	R3D5

TABLE 722-2

5 BIT RELAY CODES FOR NUMERIC CHARACTER DISPLAY

CODE	CHARACTER
00000	BLANK
10101	0
00011	1
11001	2
11011	3
01111	4
11110	5
11100	6
10011	7
11101	8
11111	9

TABLE 722-3

ERROR DESCRIPTION	DISPLAY	FILE TAPE
A word has appeared containing a relay code which is not in Table 722-2.	RELERR1	722 RELERR1, 16-bit word, time tag, and DSPTAB number.

APOLLO G&N Specification
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ACE-S/C COMPUTER SUBPROGRAM

SPECIFICATIONS FOR APOLLO

CM AND LM G & N TESTING

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	APPROVALS AC	APPROVALS NASA
12/8/66	A	32263	2,3,81,115,199,200,206,209,214-345.	EA	WLS
			Was 345 pages, Now 352 pages. KOK/AC		
12/21/66	B	32361	266, 270 KOK/AC	JP	--
1/6/67	C	32582	3,144,145,185,228-352 was 352 pages	EA	--
			now 380 pages KOK/AC		
1/26/67	D	32756	292, 295 KOK/AC	EA	--
3/2/67	E	33114	3, 265-267, 269, 274, 280, 292,	EA	--
			310-312, 332, 336, 351, 377 and 378	KOK/AC	
5/8/67	F	33950	3, 235-251, 256, 268, 269, 272, 277,	EA	--
			292, 295, 320, 321, 327, 328, 332, 333		
			344, 346, 350, 354-358 was 380, now 390 pages. KOK/AC		
7/6/67	[illegible]	34119	3, 236, 237, 241, 242, 243, 245, 247, 249, 250, 320, 381-388. Now 392 pages	EA	-- KOK/AC

This specification consists of 392 pages.

APPROVALS				
	NASA/MSC	[signature] 10/13/66		AC [signature]

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210	G & N Downlink Edit Program Block II and LEM	4-210.1
221A	AGC Downlink Format Program Block 2	4-221A.1
224A	CGC Downlink Interpretation Program, Block II	4-224A.1
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Title: EXECUTIVE SEGMENT

Purpose: The purpose of the Executive Segment is to prepare the Edit Parameters for use by the Presentation Segment, processes the Control Cards, and to extract and validate the required CGC/LGC data from the PCM Data Tape.

Input: The inputs to this segment are:

1) Downlink Edit Format and Requirements Tables (Edit Parameters)
2) Data Definition, Title and Time Cards (Control Cards)
3) PCM Data Tape or Compressed Data Tape containing the CGC/LGC data to be processed.

Output: The outputs from this segment are:

1) Edit Parameters for use by the Presentation Segment
2) CGC/LGC data extracted from the PCM Data Tape or Compressed Data Tape
3) Error signals for any discrepancies found in the Edit Parameters, the Control Cards, and the CGC/LGC data.

Normal Exit: The normal exit from this segment is to the Presentation Segment. The normal program halt occurs when the last time interval has been satisfied.

Error Exit: Error signals are generated for discrepancies found in the Input Cards, PCM or Compressed Data Tape Data. The Error Exit is to the Presentation Segment.

Description: The CGC/LGC data consists of two types of words:

1) Identification Words (2): These words indicate the type of downlink transmission (List) and signal the start of the data transmission.
2) Data Words (98 to 398): Actual CGC/LGC words. The position of a data word in a List identifies its content. There is a unique Word Order Code associated with each type of word.

The first card to be input is the Data Definition Card. This card identifies the position(Time Slot) of the CGC/LGC words in a Prime Frame of PCM Telemetry Data.

The List being sent changes during the various phases of a mission program. A set of Edit Parameters is required for each List. The number of Lists to be used during the missions utilizing Block II Computers is not known; as a preliminary estimate, this program should be able to accomodate up to twenty different lists of variable lengths from 100 to 400 words.

A set of Edit Parameters for any List will consist of:

1) List ID card - This card contains the bit configuration (in octal) of the ID Words of the List for which the tables following this card are to be used, and the length of this list.

2) R cards - These cards define the print format of the data for the particular list.

3) ENG card - These cards define the English phrase interpretations for the particular List.

4) E Cards - These cards define the processing requirements for the particular List.

5) END Card - This card is the last card of the set of Edit Parameters for the particular List.

This sequence of cards will be repeated for each List.

Run cards to be input with each run will consist of:

1) G&N card - This card will contain the description of the particular run and will be used as a page heading on the output listing.

2) TIME cards - These cards will designate the data to be processed. Each card will contain a start and a stop time in hours, minutes, and seconds. If more than one TIME card is used, the times specified will not overlap and will be in sequence.

3) END OF RUN card - signals the end of the Control Cards.

Appropriate validity checks should be made on the format of these cards. Any card error will suspend the processing of and PCM or Compressed Data Tape Data, but all cards should be scanned and all errors displayed even though no data will be processed.

Usage of the Downlink Edit Program - Block I has shown that the Edit Parameters tend to be fixed once the data content of the Downlink is known. New sets of Edit Parameters will be used only for special applications. The Executive Segment should process the Downlink Edit Format Tables and the Downlink Requirements Tables and save them on tape so that subsequent runs with the same type of data may be made with no reprocessing of those cards.

Time: There is a time signal on the PCM Data Tape and the Compressed Data Tape and the time of transmission of each CGC/LGC word can be determined. This time is matched to the time intervals requested to determine what data is to be processed. Data should be processed from the first ID following the start time to the end of the Downlist after the stop time. The time occurrence of the ID Word must be available to the Executive Segment.

Card Formats:

Data Definition Card - This card locates the two sixteen bit CGC/LGC words and the Word Order Code (WOC) contained in the 40 bits defined. This card also will define the representative WOC bit for ID Words. That is, the bit (0 or 1) indicated will be in each bit position of the WOC for ID Words. The 5-8 bit words will be considered as individual bits numbered 1 to 40 with the left most bit of the first word called bit 1 and numbered consecutively to the right most bit of the fifth word, bit 40.

Columns	Contents	Comments
1 to 4	DATA	defines card type
9 to 11	PCM	comment
13 to 19	XXX-XXX	First and last time slots of the 5-8 bit G&N PCM Words
22 to 25	WRD1	comment
27 to 31	XX-XX	first and last bit position of CGC/LGC word 1
34 to 37	WRD2	comment
39 to 43	XX-XX	first and last bit position of CGC/LGC word 2
46 to 48	WOC	comment
50 to 54	XX-XX	first and last bit position of word order code
57 to 61	IDWOC	comment
63	X	WOC representative bit for ID Words

Comments need not be checked for. The CGC/LGC words should be 16 bits in length, the word order code may be from 1 to 8 bits. All WOC bits will be identical if more than one is specified. The representative WOC bit for ID words is supplied. Data word WOC is assumed to be the complement of the ID WOC. See card example page for further clarification.

Downlink Edit Format Tables:

A Downlink Edit Format Table is required for each Downlist to be processed. This table specifies the fixed format layout of the edit listing. A field width of 120 print characters is required. The spacing alloted between the title entries of this table is for the insertion of the CGC/LGC data as processed by the Presentation Segment. This table is composed of R cards. These cards provide the titled entries for the edit listing. No more than two cards are used to define any single line of the listing. The set of R cards for any Downlist will not define over 50 lines including spacing for each page.

Columns	Contents	Comments
1	R	defines card type
6, 7	XX	line sequence number
8	y	print control
9 to 80		fixed format layout

where: XX R cards for a particular List are in sequence by this number. This number is used by the E cards to identify the lines on which the processed data will be displayed.

y = blank or 1, skip one line after printing
= 2,3, skip two lines after printing
= 4,5,6,7, skip four lines after printing
= 8, skip to next page after printing
= 9, fixed format layout of this card is the right most portion of the previously defined line

If y is blank or, 1 thru 8, columns 9 thru 80 of the card will be printed in print positions 1 to 72. If y is 9, columns 9 thru 56 will be printed in print positions 73 to 120. A one line skip is assumed if the line sequence number is unique.
If y is 9, and the line sequence number is equal to the line sequence number of the preceeding card, then this card defines print positions 73 to 120 of the previous line.

```
EG  R 012
    R 019
    R 02
    R 039
    R 04
    R 049
```

Will define 5 lines:
Line 1 of Print Positions 1 to 120
Line 2 of all blanks
Line 3 of Print Positions 1 to 72
Line 4 of Print Positions 73 to 120
Line 5 of Print Positions 1 to 120

Note that the maximum occurrence of equal line sequence numbers is twice: Once with print control of Blank, or 1 thru 8; and again with print control of 9.

Downlink Requirements Tables:

A Downlink Requirements Table is needed for each Dowalist to be processed. This table defines the specific entries required for the edit listing by referencing the index number (word position in Downlist) of the words to be processed. This table specifies the exact placement, in terms of print positions, of each data entry in the fixed edit format defined by the Downlink Edit Format Table for this Downlist. This table also specifies the processing required for each data entry in the output. A Downlink Requirements Table is composed of E cards and ENG cards.

Columns	Contents	Comments
1	E	defines card type
9, 10	XX	line number (match to R card line sequence number)
12 to 18	XXX-XXX	print positions in output line where this entry is to be displayed.
25 to 30	EQUALS	
32 to 34	XXX	index number (001 to 400)
	For quantities to be displayed in decimal:	
36 to 62	DP or SP (Double or Single Precision), Scale Factor (sign, decimal point, one to ten decimal digits), power (E, sign, one or two decimal digits), MSB (for double precision, indicates most significant bits), S or NS (if S, print sign; if NS treat word as 15 bit unsigned number).	
	For other quantities:	
36 to 50	XX or XX-XX or XX, XX-XX (bit positions to be considered - leading zeros not supplied) OCTAL (print bits indicated in octal) or BINARY (print bits indicated in binary) or ENGn (Extract bits indicated and search English table specified for match and insert associated phrase in output), I or blank (I, if bit 15 of the word is a 1, the bits indicated must be complimented before processing; if field is blank or if bit 15 is 0, the bits indicated are used as is).	
	Fields will be separated by commas, and except where mentioned, leading zeros will be supplied.	

The ENGn cards contain English phrases to be inserted in the output listing when certain combinations of bits are present in key CGC/LGC words. The bits for comparison and the table to be searched are indicated by E cards.

Columns	Contents	Comments
1 to 3	ENG	defines card type
4	n	table number (n = 1 to 8)
8 to 23	1 to 16 binary characters that is the bit pattern for which the English phrase will be substituted (bits specified n in E card are extracted and compared to the non-blank columns - right justified to column 23)	

List Identification Card - This card is the first card of the set of Edit Parameters for a particular Downlist. The bit configurations of the ID Words, whose data will be processed according to the tables following this card, are contained in this card.

Columns	Contents	Comments
1 to 4	LIST	defines card type
7 to 12	XXXXXX	bit configuration in Octal of first ID word
15 to 20	XXXXXX	bit configuration in Octal of second ID word
23 to 25	XXX	Length of Downlist

The 16 binary bits are converted into 6 octal characters by adding two binary zeros to the right to make 18 binary bits E.G. (1100100001101111) will be in the card as 620674.

End Card - This card is the last card of the set of Edit Parameters for a particular Downlist.

Columns	Contents	Comments
1 to 3	END	defines card type

The Edit Parameters for each Downlist consist of: LIST ID card, R cards, ENGn cards, E cards and the END card in that order.

Example 1

E 02, 018-026 EQUALS 062, DP, + .16777528E+5, MSB, S

E - specifies requirements equals card
02 - specifies the number of a R card entry in the Edit Format table which designates the line that this data is to be printed on.
018-026 - specifies the print positions of line 02 that this data is to be printed in
062 - specifies the position in the Downlink List (index number) that contains the data to be processed.
DP - specifies that the data is double precision
+.16777528 - specifies the numeric value of the scale factor
E+5 - specifies the power of the scale factor
MSB - specifies that word 062 is the most significant bits of the double precision quantity.
S - specifies the data is a signed number

This card requires that the 14 data bits of word 062 and the 14 data bits of word 063 be combined as previously described into a 28 bit binary fraction, converted to a decimal fraction, multiplied by 16777.528 and printed in positions 018 to 026 of line 02.

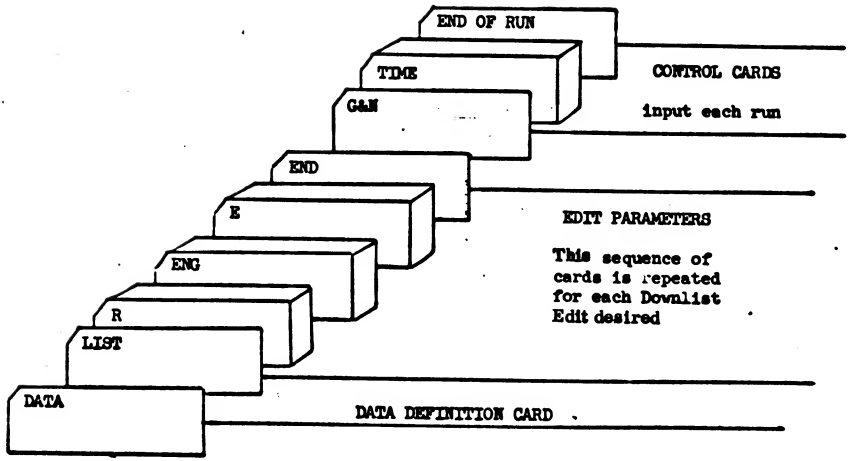
Example 2

E 61, 047-062 EQUALS 029, 7, 5-1, ENG2

E - specifies requirements Equals card
61 - specifies the number of the R card entry
047-062 - specifies the print positions of R 61 for display
29 - specifies the index number of the data
7, 5-1 - specifies the bits to be extracted from word 029
ENG2 - specifies the table of English phrases that is to be searched for the same pattern as the bits extracted.

This card requires that bits 7 and 5 thru 1 be extracted from word 029. These bits are then compared to the patterns that are part of English phrase table ENG2. When the bits are matched, the English phrase associated with that pattern is printed in print positions 047 to 062 of the line defined by R card 61.

Input Card Deck Makeup:



Input Card Examples:

```
DATA  PCM 1312-0136  WRD11 02-1-7  WRD12 1 S  33  NEC 01-01  LDNKC 11
LIST  01162541 00437374  200
R     0122ACC TIME  HRS  IMU MODE  AGC TD
ENG21  001 0001  EQUALS  ZERO ENCODER
E     02, 0118-0124  EQUALS  0124 DIF +.7454541042E+3 MSP, B
E     45, 0141-0120  EQUALS  0125 SP +.1846E+3
E     53, 0138-0154  EQUALS  0120 17 S-1  ENC2 T
E     05, 0140-0140  EQUALS  0113 1 BINARY
E     05, 0119-0123  EQUALS  0113-1 OCTAL
END
CKMP  CHKPOINT TIME  MISSION SIMULATION  AS1-202  OCP-K0035  6/6/66
TLM   14515112 TM 11532220
LNE   RUN
```

TABLE 624A-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION See Note ()	DISPLAY	SCALE FACTOR
99	CHNL 32	4	(a)	JETS 6-7 FAIL OFF (ON)	N/A
99	"	5	"	JETS 14-16 FAIL OFF (ON)	"
99	"	6	"	JETS 13-15 FAIL OFF (ON)	"
99	"	7	"	JETS 9-12 FAIL OFF (ON)	"
99	"	8	"	JETS 10-11 FAIL OFF (ON)	"
99	"	9	"	PITCH GIM OFF (ON)	"
99	"	10	"	ROLL GIM OFF (ON)	"
99	"	11-15	None	N/A	"
100	CHNL 33	1	None	N/A	"
100	"	2	(a)	RR ON/AUTO OFF (ON)	"
100	"	3	"	RR RANGE LO-SC OFF (ON)	"
100	"	4	"	RR DATA GOOD OFF (ON)	"
100	"	5	"	LR ALT D GOOD OFF (ON)	"
100	"	6	"	LR POS 1 OFF (ON)	"
100	"	7	"	LR POS 2 OFF (ON)	"
100	"	8	"	LR VEL D GOOD OFF (ON)	"
100	"	9	"	LR ALT LO-SC OFF (ON)	"
100	"	10	(j)	N/A	"
100	"	11	(a)	UPLINK TOO FAST OFF (ON)	"
100	"	12	None	N/A	"
100	"	13	"	PIPA FAIL OFF (ON)	"
100	"	14	"	LGC WARNING OFF (ON)	"
100	"	15	"	OSC ALARM OFF (ON)	"

Title: Quick Look for G&N DOWNLINK Data G&N 711

Purpose: To provide a prompt print out of the data filed by the G&N Subprogram on the UPLINK file tape.

Calling Sequence:

Entry: This program operates under Executive Control and shall be initiated from the C-START Module.

Data: Input: The data utilized by this subprogram consists of the G&N data filed as DYNAMES on the UPLINK file tape.

Output: The output will consist of the following:

1) Print out of any one file of data

2) Print out of all G&N data starting at a given range time and continuing in increments of one minute to a specified stop time

Normal Exit: Return to Executive Program control.

Error Exit: None required.

Computation Sequence:

1) This program will be stored on the master program tape and will be loaded into the ADAP memory section upon initiation from a C-START module.

2) The printout shall be considered low priority and shall not interrupt downlink compressed tape filing or the ACE station displays.

3) The programs shall automatically terminate if any UPLINK commands are transmitted.

4) Upon completion of the print out or emergency termination, the ADAP memory shall be available for other ADAP sequences or load and go programs.

5) The program shall convert the output data from the uplink file tape and print it thru the downlink computer.

6) The program shall translate DYNAMES records that have been stored by G&N DOWNLINK programs. These are DYNAMES 5 thru 15 inclusive and shall interpret each of these as follows:

TYPE		PRINTER OUTPUT
DYNAMES 5	SYNCERR 1	WDCNT XXX_{10} XXX_8 XXX_8
DYNAMES 6	SYNCERR 2	WDCNT XXX_{10} XXX_8 XXX_8
DYNAMES 7	MARKERR 1	WDCNT XXX_{10} XX_{10}
DYNAMES 8	MARKERR 2	WDCNT XXX_{10} XXX_8 XXX_8
DYNAMES 9	WORDERR 1	WDCNT XXX_{10} XXX_8 XXX_8 XXX_8 XXX_8 XXX_8
DYNAMES 10	WORDERR 2	WDCNT XXX_{10} XXX_8 XXX_8
DYNAMES 11	RELERR 1	WDCNT XXX_{10} XX_8 XX_8
DYNAMES 12	R1 SXXXXX R2 SXXXXX R3 SXXXXX NOUN XX VERB XX PROG XX UX FX	
DYNAMES 13	INO	XX_8
DYNAMES 14	LIST XA	WDCNT XXX_{10} SX_1 $X_2 \ldots X_N$; N 9
DYNAMES 15	WORDERR X	WDCNT XXX_{10} XXX_8 XXX_8 XXX_8 XXX_8 XXX_8

Where WDCNT XXX is the word number in decimal; the data field for DYNAMES 5,6, 8, 9, 10, 11, 13, and 15 is octal; the data field for DYNAMES 7, 12, and 14 may be decimal; the Sign position for DYNAMES 12 and 14 can be plus, minus or blank.

7) The program shall have the option to ignore DYNAMES types 12 and 14.

Operator Action:

1. The computer room console operator must make the proper C-START entries.

2. The computer room console operator shall notify the test conductor that no uplink activity (except for emergency) shall occur during execution of the program. The program will automatically terminate if any UPLINK activity occurs.

3. Upon completion of the program, the computer room console operator shall notify the test conductor that normal UPLINK activity can be resumed.

Title: Downlink Format and Interpretation Subprogram G&N 721

Part Of: Downlink Program

Purpose: The subprogram accepts each block of five 8-bit G&N T/M words (G&N Computer Data), reformats the block into two 16-bit G&N Computer words and checks parity. A check for the correct data sequence and a valid ID Block is also made. After these checks, the 16-bit words are available for interpretation as defined on the Downlink Requirements Cards or routed to subprogram G&N 722 for further processing. If any of the checks fail, an error flag is set.

Calling Sequence:

Entry: This subprogram operates under Downlink Executive Program Control and is initiated upon receipt of an Executive Program interrupt.

Data:

Input:
(a) A sequence of five 8-bit G&N T/M words (one block) is received each prime frame. The number of blocks for each downlist and the content of each block will be specified on the Downlink Requirements Cards. The first block in a downlist will be the ID block which identifies which downlist is to be processed.

(b) Notification upon loss of a block (Prime Frame).

Output:
(a) Valid data is available for interpretation as specified on the Downlink Requirements Cards or transmitted to ACE-S/C Subprogram G&N 722 for further processing and display.

(b) Error conditions will be displayed and recorded.

Normal Exit: Return to Executive Program Control.

Error Exit: None.

Computation Sequence:

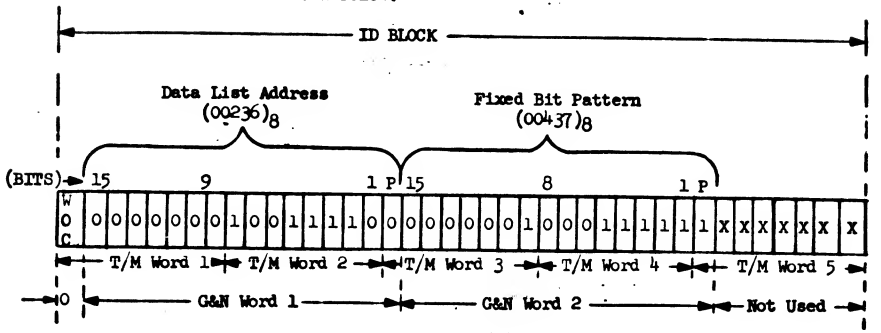
General: The program receives blocks of five 8-bit T/M words, with the following configuration:

WORD 1	WOC	15	14	13	12	11	10	9
WORD 2	8	7	6	5	4	3	2	1
WORD 3	P	15	14	13	12	11	10	9
WORD 4	8	7	6	5	4	3	2	1
WORD 5	P	X	X	X	X	X	X	X

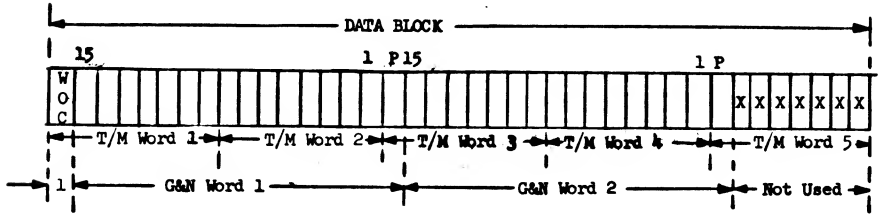
Where WOC = Word order code (1-bit)
P = Parity (G&N words have odd parity)
X = Not used

The ID block contains a zero WOC, two 16-bit words including parity bits (P) and seven unused bit positions (X). Word 1 contains the data list address in bit positions 15-1 and parity (P) in bit position zero.

Word 2 contains a fixed bit pattern sync word $(00437)_8$ in positions 15-1 and Parity (P) in bit position zero. Word 1 precedes Word 2 in the data block transmission. The word order code (WOC) bit contains a 0 for all ID blocks. An example of the ID block and word format is shown below:



The data blocks contain a WOC, two 16-bit words including parity bits (P) and seven unused bit positions (X). Word 1 precedes Word 2 in the data block transmission. The word order code (WOC) bit contains a 1 for all Data Blocks. An example of the Data Block and word format is shown below:



The G&N Computer downlist content is specified on the Downlink Requirements Cards referenced by the ID word. The position of the G&N Computer word in each fixed length list determines whether the word is to be used for data monitoring and processing or sent to G&N 722 for DSKY display monitoring.

Logic Sequence:

1. Upon initial entry, for a decommutator "loss of sync" or under conditions as specified in steps 3 and 4 below, wait for an ID block which has a word order code of 0 then initialize a word counter. If no requirement for this step, proceed to step 2.

2. Under normal conditions or successful completion of step 1 above, check parity of both the 1st and 2nd G&N Computer words of the block. If this check fails, display WORDERR 1 and file WORDERR 1 with the information defined under filing requirements. Proceed to step 3.

3. For a WOC = 0, perform ID check for:

 a. Correct data list address in bits 1-15 of 1st word in the ID block.

 b. $(00437)_8$ in bits 1-15 of the 2nd word in the ID block.

If either of the above checks fail, display WORDERR 2 and file WORDERR 2 with information defined under filing requirements. Return to wait routine specified in step 1 above.

If ID check passes, check that an ID block has not been received too soon.

If it has been received too soon, display SYNCERR 2 and file SYNCERR 2 with the information defined under filing requirements and proceed as if it had been in the correct sequence. If the ID block is received in the correct sequence, initialize the word count for processing data blocks and return to Exec. program control.

4. For a WOC$\neq$ 0, use word count to determine if an ID was expected. If it was, display SYNCERR 1 and file SYNCERR 1 with the information defined under Filing Requirements. Return to 'wait routine' specified in step 1 above. If no ID block was expected, proceed to step 5.

5. DSPTAB words +0 thru +10D are to be sent to G&N 722 along with the identifier after taking the ones complement of the DSPTAB word if bit 15 is a one (1). All other words are to be processed per the Downlink Requirements Cards.

6. When G&N Computer power is off, all bits in the T/M word blocks will be zero causing a constant WORDERR 1 and 2 display. If this condition exists, the error should be filed only once per minute.

7. When the G&N Computer is in STANDBY, all the bits in the T/M word blocks will be ONES, causing a constant WORDERR 1 and SYNCERR 1 display. If this condition exists, the error should be filed once per minute.

Downlink Requirements:

Measurement ID: Specified on the Downlink Requirements Cards.

Display: This information is detailed in the computational sequence description and consists of program error displays as specified in Table 721-1. The Downlink Requirements cards shall contain the display requirements.

Filing: Upon detection of an error, the appropriate information is recorded on the file tape as specified in Table 721-1.

TABLE 721-1

ERROR DESCRIPTION	DISPLAY	FILE TAPE
This indicates that Word count has incremented beyond a specified limit, with no ID word detected.	SYNCERR 1	SYNCERR 1, Time Tag reference, Word Count, ID block.
At this point Word Count has not reached its specified limit, but an ID block has been received.	SYNCERR 2	SYNCERR 2, Time Tag Reference Word count, ID block.
Parity is incorrect in the 1st or 2nd G&N Computer word of either an ID Block or a Data Block.	WORDERR 1	WORDERR 1, Time Tag Reference, Block count, ID or Data Block containing the parity error.
The content of the ID block is not correct.	WORDERR 2	WORDERR 2, Time Tag Reference, Word count ID Block.

Title: Display Program (DSPTAB) G&N 722

Part of: Downlink Program

Purpose: The Display Program interprets all DSPTAB words that are detected as such by the Downlink Format Program and generates displays identical in content and format to the on-board spacecraft DSKY displays. This program provides ACE-S/C ground station test personnel the capability of continuously monitoring all spacecraft keyboard displays.

Calling Sequence:

Entry: This program is activated only by the Downlink Format Program whenever program display words are to be interpreted.

Data: Input: Inputs to the Display Program shall consist of a complete 16-bit Downlink DSPTAB word and identifier.

Output: Coded information to be displayed.

Normal Exit: Return to the ACE Executive Program.

Error Exit: Error conditions shall cause error information to be displayed and recorded on the file tape. After error recording, control is returned to the ACE Executive Program. Error messages are detailed in Table 722-3.

Computation Sequence: Activation of the Display Program is attained via the Downlink Format Program. Inputs to this program will be the 16-bit Downlink word and an identifier. The identifier specifies which DSPTAB word in the Downlink list is to be processed.

The 16-bit Downlink DSPTAB word consists of four parts of coded information plus a parity bit. The four parts are:

1. Bits 15-12: The address in these bits is not used.

2. Bit 11: The special code in this bit specifies a particular discrete associated with the DSPTAB word.

3. Bits 10-6: Represent Display Codes which are associated with specific Display Names. These codes specify the numeric character to be displayed in accordance with Table 722-2.

4. Bits 5-1: Same as bits 10-6 above.

Since the contents of the DSPTAB table is sequentially transmitted Downlink, the Downlink Format Program shall supply this subprogram with the DSPTAB contents (display word) and identifier.. The display word associated with each DSPTAB is defined in Table 722-1.

Upon entry from the Downlink Format Program, the display program shall check the identifier to determine which of the 11 DSPTAB words has been received.

The Logic sequence for the DSPTAB Words depends on the state of bit 11. Below is a brief description of the action to be taken.

DSPTAB	DSPTAB WORD ACTION
+2, +8, +9D or +10D	The special code bit (bit 11), of these 4 DSPTAB words, is not applicable, therefore perform sequence 1 as described below.
+7	Bit 11 is not applicable, therefore perform sequence 2 as described below.
+1, +4, or +6	Bit 11 of these DSPTAB words is interpreted as follows: Bit 11 = 1, Set sign indicator of R to plus. Bit 11 = 0, do not change the sign indicator of R. Perform sequence 1 as described below.
+0, +3 or +5	Bit 11 of these DSPTAB words is interpreted as follows: Bit 11 = 1, set sign indicator of R to minus. Bit 11 = 0, set sign indicator of R to blank. Perform sequence 1 as described below.

NOTE: With DSPTAB +5 and +6 set the sign of R1;
DSPTAB +3 and +4 set the sign of R2;
DSPTAB +0 and +1 set the sign of R3.

Sequence 1 - extracts the relay code corresponding to bits 10-6 of the Downlink word and checks it against Table 722-2 for legality. If the code is legal the indicator is set to display the digit from Table 722-2 followed by a transfer to sequence 2. If the code is not legal clear the sign display indicator and initiate a relay-error exit. (See Table 722-3)

Sequence 2 - extracts the relay code corresponding to bits 5-1 and checks it against Table 722-2 for legality. If the code is legal the indicator is set to display the digit from Table 722-2 followed by a return to the ACE Executive Program. If the code is not legal, clear the sign and first digit display indicators and initiate a relay-error exit. (See Table 722-3)

Option - at the option of the operator an R-START may be used to transcribe the entire display on to the file tape. This R-START will be interrogated after the processing of the 11th display word. If the R-START is selected and the CRT display has changed since the last recording, the entire display is to be recorded (including FLASH and UPLINK indicators). If either the R-START is not selected or the display has not changed, no recording should be made. The recording should be prefaced by 722 Display Recording.

Operator Action:

Console Operator: The operator shall have the option of transcribing the entire display on file tape by use of an R-START as explained under "option" of the "Computation sequence".

Downlink Requirements:

Display: Display the results of the "computation sequence" sequence 1 and 2.

Filing: The results of this subprogram shall be filed as explained in the "computation sequence".

TABLE 722-1

TABLE OF DISPLAY WORDS

DSPTAB	Address Bits 15-12 Binary Code	Special Code Bit 11	Display Name Relay Code for Bits 10-6	Display Name Relay Code for Bits 5-1
+10D	N	- -	MD1	MD2
+ 9D	O	- -	VD1	VD2
+ 8D	T	- -	ND1	ND2
+ 7		- -	- -	R1D1
+ 6	U	+R1	R1D2	R1D3
+ 5	S	-R1	R1D4	R1D5
+ 4	E	+R2	R2D1	R2D2
+ 3	D	-R2	R2D3	R2D4
+ 2		- -	R2D5	R3D1
+ 1		+R3	R3D2	R3D3
+ 0		-R3	R3D4	R3D5

TABLE 722-2

5 BIT RELAY CODES FOR NUMERIC CHARACTER DISPLAY

CODE	CHARACTER
00000	BLANK
10101	0
00011	1
11001	2
11011	3
01111	4
11110	5
11100	6
10011	7
11101	8
11111	9

TABLE 722-3

ERROR DESCRIPTION	DISPLAY	FILE TAPE
A word has appeared containing a relay code which is not in Table 722-2.	RELERR1	722 RELERR1, 16-bit word, time tag, and DSPTAB number.

APOLLO G&N Specification
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ACE-S/C COMPUTER SUBPROGRAM

SPECIFICATIONS FOR APOLLO

CM AND LM G & N TESTING

Record of Revisions

Date	Revision Letter	TDRR No.	Pages Revised	Approvals	
				AC	NASA
7/27/67	H	34236	3, 268, 335, 336, 347, 351,	EA	---
			354, 355, 356, 358. Was 392		
			pages; now 398 pages. DCR 1 & 2		

This specification consists of page 1 to 398 inclusive.

APPROVALS	NASA/MSC	MIT/IL	AC

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221A	AGC Downlink Format Program Block 2	4-221A.1
224A	CGC Downlink Interpretation Program, Block II	4-224A.1
601	Guidance Computer Clock Initialization Program	4-601.1
602	Guidance Computer Time Verification Program	4-602.1
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731	Uplink Transmission Program	4-731.1

TABLE 224A-2 (Continued)

WORD NO.	WORD NAME	BIT	DATA MANIPULATION See Notes (-)	DISPLAY	SCALE FACTOR
98	CHNL 31	1	(a)	+PITCH MAN ROT OFF (ON)	N/A
98	CHNL 31	2	(a)	-PITCH MAN ROT OFF (ON)	N/A
98	CHNL 31	3	(a)	+YAW MAN ROT OFF (ON)	N/A
98	CHNL 31	4	(a)	-YAW MAN ROT OFF (ON)	N/A
98	CHNL 31	5	(a)	+ROLL MAN ROT OFF (ON)	N/A
98	CHNL 31	6	(a)	-ROLL MAN ROT OFF (ON)	N/A
98	CHNL 31	7	(a)	+X TRANS OFF (ON)	N/A
98	CHNL 31	8	(a)	-X TRANS OFF (ON)	N/A
98	CHNL 31	9	(a)	+Y TRANS OFF (ON)	N/A
98	CHNL 31	10	(a)	-Y TRANS OFF (ON)	N/A
98	CHNL 31	11	(a)	+Z TRANS OFF (ON)	N/A
98	CHNL 31	12	(a)	-Z TRANS OFF (ON)	N/A
98	CHNL 31	13	(a)	CMC MODE HOLD OFF (ON)	N/A
98	CHNL 31	14	(a)	CMC MODE FREE OFF (ON)	N/A
98	CHNL 31	15	(a)	G/N CONTROL OFF (ON)	N/A
99	CHNL 32	1	(a)	+PITCH MIN IMP OFF (ON)	N/A
99	CHNL 32	2	(a)	-PITCH MIN IMP OFF (ON)	N/A
99	CHNL 32	3	(a)	+YAW MIN IMP OFF (ON)	N/A
99	CHNL 32	4	(a)	-YAW MIN IMP OFF (ON)	N/A
99	CHNL 32	5	(a)	+ROLL MIN IMP OFF (ON)	N/A
99	CHNL 32	6	(a)	-ROLL MIN IMP OFF (ON)	N/A
99	CHNL 32	7-10	NONE	N/A	N/A
99	CHNL 32	11	(a)	LM ATTACHED OFF (ON)	N/A
99	CHNL 32	12-15	NONE	N/A	N/A
100	CHNL 33	1-9	NONE	N/A	N/A
100	CHNL 33	10	(a), (h)	BLOCK UPLINK OFF (ON)	N/A
100	CHNL 33	11	(a)	UPLINK TOO FAST OFF (ON)	N/A
100	CHNL 33	12	NONE	N/A	N/A
100	CHNL 33	13	(a)	PIPA FAIL OFF (ON)	N/A
100	CHNL 33	14	(a)	CMC WARNING OFF (ON)	N/A
100	CHNL 33	15	(a)	OSC ALARM OFF (ON)	N/A

TABLE 624-200-1

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION			DISPLAY
			Code*	Scale Factor	See Note ()	
1	ID	1-15	C20			N/A
2	ID	1-15	C20			
3	STATE VEC X POS MSB AVE-G	1-15	N/A			
4	STATE VEC X POS LSB AVG-G	1-15				
5	STATE VEC Y POS MSB AVE-G	1-15				
6	STATE VEC Y POS LSB AVE-G	1-15				
7	STATE VEC Z POS MSB AVE-G	1-15				
8	STATE VEC Z POS LSB AVE-G	1-15				
9	STATE VEC X VEL MSB AVE-G	1-15				
10	STATE VEC X VEL LSB AVE-G	1-15				
11	STATE VEC Y VEL MSB AVE-G	1-15				
12	STATE VEC Y VEL LSB AVE-G	1-15				
13	STATE VEC Z VEL MSB AVE-G	1-15				
14	STATE VEC Z VEL LSB AVE-G	1-15				
15	STATIME MSB	1-15				
16	STATIME LSB	1-15				
17						
18	DESIRED CDU X	1-15				
19	DESIRED CDU Y	1-15				
20	DESIRED CDU Z	1-15				
21	DELV X MSB	1-15				
22	DELV X LSB	1-15				
23	DELV Y MSB	1-15				
24	DELV Y LSB	1-15				
25	DELV Z MSB	1-15				
26	DELV Z LSB	1-15	N/A			N/A
27	LMPCMD	1-15	C6		(a)	LMP XXX
28	LMPCMD + 1	1-15	C6		(a)	XXX
29	LMPCMD + 2	1-15	C6		(a)	XXX
30	LMPCMD + 3	1-15	C6		(a)	XXX
31	LMPCMD + 4	1-15	C6		(a)	XXX
32	LMPCMD + 5	1-15	C6		(a)	XXX

* Refer to Table 624-200-2

TABLE 624-200-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION			DISPLAY	
			Code*	Scale Factor	See Note ()		
33	LMPCMD +6	1-15	C6	1	(a)	XXX	
34	LMPCMD +7	1-15	C6	1	(a)	XXX	
35	LMP IN	1-15	C3	1	(c)	LMP IN X	
36	LMP OUT	1-15	C3	1	(c)	LMP OUT X	
37	SPARE	1-15					
38	SPARE	1-15					
39	UPVERB	1-15	N/A				N/A
40	COMPNUMB	1-15	N/A				N/A
41	STATE COUNT	1-15	C3	1	(b)	STCN TRXX	N/A
42	UPOLDMOD	1-15	N/A				N/A
43	ST BUFF +0	1-15	C6			R XXXXX	
44	STBUFF +1	1-15	C6			XXXXX	
45	ST BUFF +2	1-15	C6			XXXXX	
46	ST BUFF +3	1-15	C6			XXXXX	
47	ST BUFF +4	1-15	C6			XXXXX	
48	ST BUFF +5	1-15	C6			XXXXX	
49	ST BUFF +6	1-15	C6			V XXXXX	
50	ST BUFF +7	1-15	C6			XXXXX	
51	ST BUFF +8D	1-15	C6			XXXXX	

* Refer to Table 624-200-2

TABLE 624-200-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION			DISPLAY
			Code*	Scale Factor	See Note ()	
121	SPARE	1-15				
122	SPARE	1-15				
123	SPARE	1-15				
124	SPARE	1-15				
125	SPARE	1-15				
126	SPARE	1-15				
127	LMPCMD	1-15	C6		(a)	LMP XXX
128	LMPCMD +1	1-15	C6		(a)	XXX
129	LMPCMD +2	1-15	C6		(a)	XXX
130	LMPCMD +3	1-15	C6		(a)	XXX
131	LMPCMD +4	1-15	C6		(a)	XXX
132	LMPCMD +5	1-15	C6		(a)	XXX
133	LMPCMD +6	1-15	C6		(a)	XXX
134	LMPCMD +7	1-15	C6		(a)	XXX
135	LMPIN	1-15	C3	1	(c)	LMP IN X
136	LMPOUT	1-15	C3	1	(c)	LMP OUT X
137	SPARE	1-15				
138	SPARE	1-15				
139	MISSION PHASE REG 4	1-15	C3	1	(b)	MPHASE XX
140	MISSION PHASE REG 3	1-15	C3	1	(b)	XX
141	MISSION PHASE REG 2	1-15	C3	1	(b)	XX
142	MISSION PHASE REG 1	1-15	C3	1	(b)	XX
143	MISSION TIME REG 4	1-15	C3	1		MPTIME XXXXX
144	MISSION TIME REG 3	1-15	C3	1		XXXXX
145	MISSION TIME REG 2	1-15	C3	1		XXXXX
146	MISSION TIME REG 1	1-15	C3	1		XXXXX SEC
147	PHASE NUM	1-15	C3	1	(b)	PHASE NUM XX
148	1/PIPADT	1-15	N/A			N/A
149	TIME TO GO MSB	1-15	C4			TTGO XXXX HR XX MIN XX.XX SEC
150	TIME TO GO LSB	1-15	C5,C9	1		
151	BURN DATA	1-15	N/A			N/A

* Refer to Table 624-200-2.

Notes:

a. The resulting number will not exceed 3 digits and the display will consist of the nine least significant bits converted to octal.

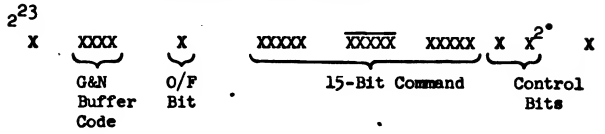
b. The resulting decimal numbers will not exceed 2 digits, [illegible] thru [illegible].

c. The resulting decimal numbers will not exceed 1 digit for words 35, 36, 135, and 136.

d. Flash verb numbers and noun numbers.

and required control bits as shown below.

G&N UPLINK WORD FORMAT



Prior to transmittal of a sequence of command words, a check is made on the GC discrete "BLOCK UPLINK". If this discrete is "ON", then a non-verify display will occur on the K-START, the keycode will not be transmitted and a normal system recording will occur on the command tape as specified in Table 631-1.

If UPLINK is not BLOCKED, a sequence of tests are made on the incoming keycodes to determine if the command sequence contains a V36. If so, two GC discretes are monitored, namely the "Gimbal Lock" and the "IMU Operate". If both discretes are set to a "ON" state, then a "non-verify" display will occur on the K-START and the next keycode will not be transmitted Uplink. Another discrete is monitored, the "Operator Error" flashing discrete. An error status will cause this subprogram to terminate the processing of GC commands by inhibiting further K-START data entry with a "non-verify" signal. A normal system recording will occur on the command tape as specified in Table 631-1.

The final discrete tested is UPLOCK, A "ON" state will result in a test for an "alarm reset" keycode. If this code is available, then two commands will be transmitted at the correct frequency. The first command will zero the GC Uplink register and the second, namely, the "reset" keycode will possibly reset the alarm indication triggered by UPLOCK. The "OFF" state for this discrete, will allow the subprogram to continue and transmit the commands to the GC with subsequent recordings on the command tape.

The K-START module is sealed after receipt of a keycode to allow the correct transmission frequency to the GC to be utilized. The sealing can occur as soon as a "good" CSR is received from the DTCS, after which a time delay is utilized to give an approximate maximum input rate to the GC of six keycodes / sec.

A "bad" CSR response should cause the K-START to display a "non-verify" and subsequently be unsealed, to allow further operator action to be taken. It should be

noted at this point, that as the state of the above mentioned discretes can change at a maximum of only once every second, approximately eight commands could be transmitted Uplink before repeating discrete testing. Figure 631-1 is given as a representative flow, to convey the intent of the subprogram operation.

Operator Action:

During the processing of the input keycodes a test is made to determine whether the range time since "Sealing" the K-START module is greater than or equal to the time delay factor entered via C-START. If so, the verify indication is displayed and the subprogram then transfers control to the Uplink Executive program. If not, the module remains "Sealed" to inhibit further input through the K-START module until the time delay has elapsed. This regulates the input rate of keycodes to the GC. A nominal time delay factor is 90 milliseconds.

Console Operator: Operator action is required to initiate this sub-program by entering data via the K-START module keyboard or tape reader.

When a NON-VERIFY display occurs, further character entry is allowed after depression of the NON-VERIFY switch.

For tape mode of operation enter 3100000XXX into C-START. XXX is the time delay factor in milliseconds.

The operator's responsibility includes the monitoring of displays and the initiation of procedures based upon the display interpretation. Normally the status of the "BLOCK UPLINK" CRT display should be reviewed by the operator prior to insertion of data through the K-START module. However, this K-START subprogram will monitor this discrete, and inhibit any data transfer if this discrete gives an "ON" condition. The "non-verify" display which occurs under this condition will then be reset by the operator. If the "Operator Error On" condition appears, this subprogram will inhibit data transfer through the K-START with a non-verify. The operator will reset this "non-verify" switch and insert a "reset" keycode to clear the "Operator Error" display. Then correct the illegal data sequence and re-enter through the K-START.

An "UPLOCK" display will again inhibit data transfer through the K-START. The operator will reset the "non-verify" and insert a "reset" keycode to clear the discrete. The subprogram will then transmit a "zero" message followed by the "reset" keycode. This may reset the "UPLOCK" discrete and the operator can continue his interrupted sequence of commands by re-inserting the previous keycode.

Two other conditions cause this subprogram to inhibit data input through the K-START, they are a parity error and an invalid keycode. The operator will release the non-verify and apply corrective measures to the input.

If a "Keyerr 2" CRT display occurs, then the operator should re-insert the "Verb 36 Enter" sequence after monitoring the "Gimbal Lock" and "IMU Operate" discrete displays.

Commands inserted via the keyboard will be verified by means of the "closed loop" display, which depicts the GC DSKY status on the CRT, prior to depression of the "Enter" keycodes. The punched tape input, if visual verification is desired, should contain strategically located "stop" codes in the Verb/Noun and parameter sequences, to allow the operator time to perform verificaiion.

Spacecraft Operator: No activity required.

Uplink Requirements:

DTCS Transmission: The data word transmitted to the G&N buffer is identified in the Computation Sequence and will be generated as required.

DTCS Stimuli: None

Transmission Time: During G&N testing this will be specified in the Operational Checkout Procedure. All other times will be as required.

Filing: 1) All K-START command information will be recorded on the command tape.

2) Additional recordings for error conditions and discrete inhibits are specified in Table 631-1.

Table 631-1

CRT Error Display Definition

Error or Discrete	CRT Display	K-START Module Display	Command Tape Edit
Odd parity does not exist in the data frame received from K-START module.	PARERR 1	Non-Verify	631, PARERR 1, Time Ref.
An invalid GC keycode has been received by this sub-program.	KEYERR 1	Non-Verify	631, KEYERR 1, Time Ref.
An illegal entry of a V36E has occured.	KEYERR 2	Non-Verify	631, KEYERR 2, Time Ref.
No keycodes can be received by the GC via Uplink, therefore further keycode entry through the K-START is inhibited.	BLOCK UPLINK ON*	Non-Verify	631, Block Uplink Time Ref.
This indicates than an incorrect keycode loading procedure has occured and entry through the K-START is inhibited.	OPERATOR ERROR ON*	Non-Verify	631, Op. Error, Time Ref.

*These CRT discrete displays are set by G&N 224A, 624A, 624B or 624-200 ACE-S/C Downlink Interpretation Program.

Title: Uplink Transmission Program G&N 731

Part Of: Uplink Program

Purpose: This subprogram checks the received keycode inputs for parity and valid codes and then formats them into a command word for transmission to the External DTCS. The status of the Uplink system and the G&N Computer is monitored, and the Uplink command sequence is controlled to the acceptable input rate of the G&N Computer.

Calling Sequence:

Entry: This subprogram operates under Uplink Executive Program control and may be initiated via K-START, G&N Subprograms or special purpose parametric input routines ("ADAP").

Data:

Input:

1) The data content utilized by this subprogram consists of a five bit Keycode plus a parity bit (odd parity). The input consists of information received from K-START punched tape (Automatic Mode) or from the K-START Keyboard (Manual Mode), from G&N Subprogram or from a special purpose parametric input routine (ADAP).

2) Keycode delay factor of XXX milliseconds entered via C-START.

3) Options entered via R-STARTS as defined in the PRPS/PRD. These options are:

 a) Verify or Load-Verify

 b) Block Uplink Override

Output: Output will consist of a sequence of formated data words, which is transmitted to the G&N buffer, the time delay factor display and error displays.

Normal Exit: Return to Uplink Executive Program.

Error Exit: Error conditions will be displayed for the operator and recorded on the Uplink File Command Tape. These error conditions are subsequently described in Table 731-2.

Computation Sequence: This subprogram shall initialized by a Keycode entry from any of the following:

Computation Sequence (cont'd)

1. Operator action by means of the K-START module, either in manual or automatic modes.

2. Upon entry from a G&N Subprogram.

3. Upon entry from a special purpose parametric input routine (ADAP).

This subprogram shall then perform the following:

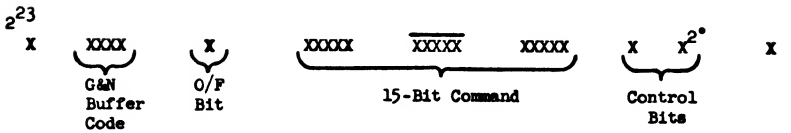
1. Check for the R-START module VERIFY & LOAD VERIFY XEQ upon entry of a keycode into this subprogram. If this XEQ is detected transfer control to G&N 732. If this XEQ is not detected proceed.

2. Check the received Keycode with the parity bit to assure that odd parity exists. If this parity check fails terminate entry and/or generate NON-VERIFY on K-START module depending on source of entry. Inhibit the transmission of the Keycode and display and record the error condition as specified in Table 731-2.

3. Check the validity of the received keycode. The valid keycodes are listed in Table 731-1. If the keycode is not valid terminate entry and/or generate a NON-VERIFY on the K-START, inhibit the transmission of the keycode and display and record the error condition as specified in Table 731-2.

4. Transform the valid keycode into a 16-bit word and combine it with the DTCS G&N buffer address and required control bits as indicated in Figure 731-1.

G&N UPLINK WORD FORMAT



- FIGURE 731-1 -

Computation Sequence (Cont'd.)

5. Check the Block Uplink discrete and if ON, check the R-START "Block Uplink Override." If Block Uplink is ON and "Block Uplink Override" is OFF, terminate entry and generate a "NON-VERIFY" on the K-START, inhibit the transmission of the keycode and record the error condition as specified in Table 731-2. If Block Uplink is ON and Block Uplink Override is ON, inhibit the "NON-VERIFY" and allow further tests on the keycode. Each keycode transmitted to the G&N Computer when Block Uplink is ON and Block Uplink Override is ON shall be recorded on the Uplink File Tape as normal along with the R-START number of Block Uplink Override.

6. Check for V36 in a verb command sequence. If V36 is present and both Gimbal Lock and IMU Operate discretes are ON, terminate entry and generate a "NON-VERIFY" on the K-START, inhibit the Verb command sequence from entry into the G&N Computer and display and record the error condition as specified in Table 731-2.

7. Check the Operator Error discrete. If this discrete is ON and the Keycode is a Reset Keycode, transmit the Reset Keycode after the proper delay. If the Operator Error discrete is ON and the Keycode is not a Reset Keycode terminate entry and generate a "NON-VERIFY" on the K-START, inhibit the transmission of the Keycode and record the error condition as specified in Table 731-2. The Operator Error discrete shall be cleared upon entry of a Reset Keycode by the operator after the "NON-VERIFY" switch is reset. This allows the operator to continue sending the interrupted sequence of commands by re-inserting the previous Keycode.

8. Check the UPLOCK discrete. If this discrete is ON and the Keycode is a Reset Keycode, zero the G&N Computer Uplink register and transmit the Reset Keycode after the proper delay. If the Uplock discrete is ON and the Keycode is not a Reset Keycode terminate entry and generate a "NON-VERIFY" on the K-START, inhibit the transmission of the K-START, inhibit the transmission of the keycode and record the error condition as specified in Table 731-2. The UPLOCK discrete shall be cleared upon entry of a Reset Keycode by the Operator after the "NON-VERIFY" switch is reset. This allows the operator to continue sending the interrupted sequence of commands by re-inserting the previous Keycode.

Computation Sequence (cont'd)

9. Check the CSR message from the DTCS after the transmission of every keycode. If the CSR is "good", unseal the entry after the specified time delay. (The time delay is utilized to control the input rate of the Keycodes to the G&N Computer and shall nominally be 90 milliseconds unless modified by C-START.). If the CSR is "bad" terminate entry and generate a "NON-VERIFY" on the K-START and unseal the entry to allow further operator action.

10. Check for the R-START module Verify or Load Verify XEQ. If this XEQ is detected transfer control to G&N 732.

11. Generate a verify on the K-START and/or return to the Uplink Executive depending upon source of entry.

12. Display the following:

 a. The time delay factor in XXX milliseconds and the appropriate nomenclature.

 b. Program error displays as specified in Table 731-2.

Operator Action:

Console Operator: See "Computation Sequence".

Uplink Requirements:

DTCS Transmission: The data word transmitted to the G&N buffer is identified in the Computation Sequence and will be generated as required.

Filing:

1) All K-START command information will be recorded on the command tape.

2) Additional recordings for error conditions and discrete inhibits are specified in Table 731-2.

3) Each G&N Computer Uplink word transmitted while Block Uplink is ON will be filed on the Uplink File Tape along with the R-START number of the Block Uplink Override Command.

- TABLE 731-1 -

LEGAL G&N COMPUTER KEYCODES

Character	Code (MSB LSB)
0	10000
1	00001
2	00010
3	00011
4	00100
5	00101
6	00110
7	00111
8	01000
9	01001
VERB	10001
RESET	10010
KEY RELEASE	11001
PLUS	11010
MINUS	11011
ENTER	11100
CLEAR	11110
NOUN	11111

- TABLE 731-2 -

ERROR DISPLAY DEFINITION

Error or Discrete	Display	K-START Module Display	Command Tape Edit
Odd parity does not exist in the data frame received.	PARERR 1	Non-Verify	731, PARERR 1, Time Ref.
An invalid G&N Computer keycode has been received by this subprogram.	KEYERR 1	Non-Verify	731, KEYERR 1, Time Ref.
An illegal entry of a V36E has occurred.	KEYERR 2	Non-Verify	731, KEYERR 2, Time Ref.
This indicates that an incorrect keycode loading procedure has occurred and that further entry is inhibited.	OPERATOR ERROR ON*	Non-Verify	731, Op. Error, Time Ref.
This indicates that a previous keycode was not transmitted correctly and that the present keycode is not a reset keycode.	UPLOCK ON*	Non-Verify	731, FORMERR, Time Ref.
No keycodes can be received by the G&N Computer via Uplink, therefore further keycode entry is inhibited.	BLOCK UPLINK ON*	Non-Verify**	731, Block Uplink ON, Time Ref.
Bad CSR	BAD CSR	Non-Verify	None

* These displays are set by the Guidance Computer Downlink Format and Interpretation Program G&N 721.

** A Verify display will occur if the R-START "Block Uplink Override" has been executed.

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ACE-S/C COMPUTER SUBPROGRAM

SPECIFICATIONS FOR APOLLO

CM AND LM G & N TESTING

Record of Revisions

	Date	Revision Letter	TDRR No.	Pages Revised	Approvals AC	Approvals NASA
(W)	7/27/67	H	34236	3, 268, 335, 336, 347, 351,	EA	---
				354, 355, 356, 358. Was 392		
				pages; now 398 pages. ROG/AC		
	8/31/67	J	34461	3, 317, 319, 328, 331, 342, 381,	EA	---
				382 ROG/AC		

This specification consists of page 1 to 398 inclusive.

APPROVALS	NASA/MSC	MIT/IL	AC

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181	PIPA Switching and Stabilization Response Test.	4-181.1
210	G & N Downlink Edit Program Block II and LEM	4-210.1
221A	AGC Downlink Format Program Block 2	4-221A.1
224A	CGC Downlink Interpretation Program, Block II	4-224A.1
601	Guidance Computer Clock Initialization Program	4-601.1
602	Guidance Computer Time Verification Program	4-602.1
603	Guidance Computer Time Correction Program	4-603.1
621	Guidance Computer Downlink Format Program	4-621.1
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624A	LEM Downlink Interpretation Program	4-624A.1
624B	LGC Downlink Interpretation Program	4-624B.1
624-200	LGC Downlink Interpretation Program	4-624-200.1
631	Guidance Computer Uplink Verification Program	4-631.1
632	Special K-Start Load-Verify, Verify, and Dump Program	4-632.1
641	G & N High Rate Channel Control Program	4-641.1
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TABLE 624A-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION See Note ()	DISPLAY	SCALE FACTOR
60	ANG Z + 1	1-15	None	N/A	N/A
61	ANG Y/PIPA E		Display in Octal	ANG Y/PIPA E XXXXX	"
62	ANG Y + 1		None	N/A	"
63	ANG X/PIPA E		Display in Octal	ANG X/PIPA E XXXXX	"
64	ANG X + 1		None	N/A	"
65	V LAUN		None	N/A	"
66	V LAUN + 1		None	"	"
67	V LAUN + 4		None	"	"
68	V LAUN + 5		None	"	"
69	R STACK (MS)	1-15	(c),(e) Convert to Decimal	RR RANGE ±XXXXXXXXXX.XXX FT	+9.38 FT
70	R STACK + 1 (LS)	1-15		LR VX ±XXXXXXXX.XXXXX FPS	-0.6435 FPS
71	R STACK + 6 (MS)	1-15	(c),(e) Convert to Decimal	RR RANGE RATE ±XXXXXXXXX. XXXX FPS	-0.6278 FPS
72	R STACK + 7 (LS)	1-15		LR VY ±XXXXXXXX.XXXXX FPS	+1.2525 FPS
73	R STACK +12D(MS)	1-15	(c) Convert to Decimal	LR VZ ±XXXXXXXX.XXXXX FPS	+0.8571 FPS
74	R STACK +13D(LS)	1-15			
75	R STACK +18D(MS)	1-15	(c) Convert to Decimal	LR ALT ±XXXXXXXXX.XXXXXFT	+1.0795 FT
76	R STACK +19D(LS)	1-15			
77	UPLOCK	1	(a)(f)	UPLOCK ON (OFF)	N/A
77	UPLOCK	2-15	None	N/A	N/A
78	T6LOC		None	"	"
79	DSPTAB + 0	1-15	"	"	"
80	DSPTAB + 1	1-15	"	"	"
81	DSPTAB + 2	1-15	"	"	"
82	DSPTAB + 3	1-15	"	"	"
83	DSPTAB + 4	1-15	"	"	"
84	DSPTAB + 5	1-15	"	"	"
85	DSPTAB + 6	1-15	"	"	"
86	DSPTAB + 7	1-15	"	"	"
87	DSPTAB + 8	1-15	"	"	"
88	DSPTAB + 9	1-15	"	"	"
89	DSPTAB + 10	1-15	"	"	"
90	DSPTAB + 11	1-3	None	"	"
90	DSPTAB + 11	4	(a)	NO ATTITUDE ON (OFF)	"
90	DSPTAB + 11	5	None	N/A	"
90	DSPTAB + 11	6	(a)(f)	GIMBAL LOCK ON (OFF)	"
90	DSPTAB + 11	7	None	N/A	"
90	DSPTAB + 11	8	(a)	TRACKER FAIL ON (OFF)	"

TABLE 624A-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION See Note ()	DISPLAY	SCALE FACTOR
96	CHNL 14	3	(a)	ALT METER ACT ON (OFF)	N/A
96	"	4	(a)	THRUST DRV ON (OFF)	"
96	"	5-15	None	N/A	"
97	CHNL 30	1	(a)	ABORT OFF (ON)	"
97	"	2	"	STAGE VERIF ON (OFF)	"
97	"	3	"	ENG ARMED OFF (ON)	"
97	"	4	"	ABORT STAGE OFF (ON)	"
97	"	5	"	AUTO THROT OFF (ON)	"
97	"	6	"	DSP INRTL DATA OFF (ON)	"
97	"	7	"	RR CDU FAIL OFF (ON)	"
97	"	8	None	N/A	"
97	"	9	(a)(f)	IMU OPERATE OFF (ON)	"
97	"	10	(a)	G&N CNTL LEM OFF (ON)	"
97	"	11	"	IMU CAGE OFF (ON)	"
97	"	12	"	ISS CDU FAIL OFF (ON)	"
97	"	13	"	IMU FAIL OFF (ON)	"
97	"	14	"	ISS TURNON RQST OFF (ON)	"
97	"	15	"	TEMP IN LIM OFF (ON)	"
98	CHNL 31	1	(a)	+EL LPD, +PMI OFF (ON)	"
98	"	2	"	-EL LPD, -PMI OFF (ON)	"
98	"	3	"	+YMI OFF (ON)	"
98	"	4	"	-YMI OFF (ON)	"
98	"	5	"	+AZ LPD, +RMI OFF (ON)	"
98	"	6	"	-AZ LPD, -RMI OFF (ON)	"
98	"	7	"	+X TRANS OFF (ON)	"
98	"	8	"	-X TRANS OFF (ON)	"
98	"	9	"	+Y TRANS OFF (ON)	"
98	"	10	"	-Y TRANS OFF (ON)	"
98	"	11	"	+Z TRANS OFF (ON)	"
98	"	12	"	-Z TRANS OFF (ON)	"
98	"	13	"	ATTITUDE HOLD OFF (ON)	"
98	"	14	"	AUTO MODE OFF (ON)	"
98	"	15	"	ATT CNTR DETENT OFF (ON)	"
99	CHNL 32	1	(a)	JETS 2-4 FAIL OFF (ON)	"
99	"	2	"	JETS 5-8 FAIL OFF (ON)	"
99	"	3	"	JETS 1-3 FAIL OFF (ON)	"

TABLE 624B-1 (Continued)

WORD NUMBER	WORD NAME	BIT (S)	DATA MANIPULATION See Note ()	DISPLAY
46	THETAD + 1	1-15	None	N/A
47	THETAD + 2	1-15	None	N/A
48	DELVX	1-15	None	N/A
49	MARKSTAT	1-15	None	N/A
50	XY MARK	1-15	None	N/A
51	DRIFT 0	1-15	CTDEC SF = $1000/2^{14}$ MERU	VDRIFT 0 ±XXX.XX MERU
52	DRIFT 0 + 1	1-15	None	N/A
53	DRIFT 1	1-15	CTDEC SF = $1000/2^{14}$ MERU	SDRIFT I ±XXX.XX MERU
54	DRIFT 1 + 1	1-15	None	N/A
55	DRIFT 2	1-15	CTDEC SF = $1000/2^{14}$ MERU	EDRIFT T ±XXX.XX MERU
56	DRIFT 2 + 1	1-15	None	N/A
57	TORQUE 0	1-15	None	N/A
58	TORQUE + 1	1-15	None	N/A
59	ANG Z	1-15	CTDEC SF = 1	ANG Z ±XXXXX
60	ANG Z + 1	1-15	None	N/A
61	ANG Y/PIPA N	1-15	CTOCT	ANG Y/PIPA N XXXXX
62	ANG Y + 1	1-15	None	N/A
63	ANG X/PIPA E	1-15	CTOCT	ANG X/PIPA E XXXXX
64	ANG X + 1	1-15	None	N/A
65	V LAUN	1-15	None	N/A
66	V LAUN + 1	1-15	None	N/A
67	V LAUN + 4	1-15	None	N/A
68	V LAUN + 5	1-15	None	N/A
69	R STACK (MS)	1-15	(c), (e) SF = +8.38 FT	RR RANGE ±XXXXXXXXXX.XX FT
70	R STACK + 1 (LS)	1-15	(c), (e) SF = +0.6435 FPS	LR VX ±XXXXXXXXX.XXXX FPS
71	R STACK + 6 (MS)	1-15	(c), (e) SF = +0.6278 FPS	RR RANGE RATE ±XXXXXXXXX.XXXX FPS
72	R STACK + 7 (LS)	1-15	(c), (e) SF = +1.2525 FPS	LR VY ±XXXXXXXXX.XXXX FPS
73	R STACK +12D (MS)	1-15	(c) SF = +0.8571 FPS	LR VZ ±XXXXXXXXX.XXXX FPS
74	R STACK +13D (LS)	1-15		
75	R STACK +18D (MS)	1-15	(c) SF = +1.0795 FT	LR ALT ±XXXXXXXXX.XXX FT
76	R STACK +19D (LS)	1-15		

TABLE 624B-1 (Continued)

WORD NUMBER	WORD NAME	BIT (S)	DATA MANIPULATION See Note ()	DISPLAY
96	CHNL 14	5-15	None	N/A
97	CHNL 30	1	(a)	ABORT _____ (ON)
97	CHNL 30	2	(a)	STAGE VERIF ON ()
97	CHNL 30	3	(a)	ENG ARMED _____ (ON)
97	CHNL 30	4	(a)	ABORT STAGE _____ (ON)
97	CHNL 30	5	(a)	AUTO THROT _____ (ON)
97	CHNL 30	6	(a)	DSP INRTL DATA _____ (ON)
97	CHNL 30	7	(a)	RR CDU FAIL _____ (ON)
97	CHNL 30	8	None	N/A
97	CHNL 30	9	(a) (f)	IMU OPERATE _____ (ON)
97	CHNL 30	10	(a)	G&N CNTL LEM _____ (ON)
97	CHNL 30	11	(a)	IMU CAGE _____ (ON)
97	CHNL 30	12	(a)	ISS CDU FAIL _____ (ON)
97	CHNL 30	13	(a)	ISS FAIL _____ (ON)
97	CHNL 30	14	(a)	ISS TURNON RQST _____ (ON)
97	CHNL 30	15	(a)	TEMP IN LIM _____ (ON)
98	CHNL 31	1	(a)	+EL LPD, +PMI _____ (ON)
98	CHNL 31	2	(a)	-EL LPD, -PMI _____ (ON)
98	CHNL 31	3	(a)	+YMI _____ (ON)
98	CHNL 31	4	(a)	-YMI _____ (ON)
98	CHNL 31	5	(a)	+AZ LPD, +RMI _____ (ON)
98	CHNL 31	6	(a)	-AZ LPD, -RMI _____ (ON)
98	CHNL 31	7	(a)	+X TRANS _____ (ON)
98	CHNL 31	8	(a)	-X TRANS _____ (ON)
98	CHNL 31	9	(a)	+Y TRANS _____ (ON)
98	CHNL 31	10	(a)	-Y TRANS _____ (ON)
98	CHNL 31	11	(a)	+Z TRANS _____ (ON)
98	CHNL 31	12	(a)	-Z TRANS _____ (ON)
98	CHNL 31	13	(a)	ATTITUDE HOLD _____ (ON)
98	CHNL 31	14	(a)	AUTO STAB _____ (ON)
98	CHNL 31	15	(a)	ATT CNTR DETENT _____ (ON)

TABLE 624-200-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION			DISPLAY
			Code*	Scale Factor	See Note ()	
83, 183	CHANNEL 13	1-4	C20			N/A
83, 183	CHANNEL 13	5	C1, C20			INHIB UPLINK ON ()
83, 183	CHANNEL 13	6-9	C20			N/A
83, 183	CHANNEL 13	10	C1, C20			TEST ALARMS ON ()
83, 183	CHANNEL 13	11	C1, C20			ABL LGC STBY ON ()
83, 183	CHANNEL 13	12-15	C20			N/A
84, 184	CHANNEL 14	1	C20			N/A
84, 184	CHANNEL 14	2	C1, C20			ALT RATE SEL ON ()
84, 184	CHANNEL 14	3	C1, C20			ALT METER ACT ON ()
84, 184	CHANNEL 14	4	C1, C20			THRUST DRV ON ()
84, 184	CHANNEL 14	5-15	C20			N/A
85, 185	CHANNEL 30	1	C2, C20			ABORT ——(ON)
85, 185	CHANNEL 30	2	C2, C20			STAGE VERIF ON ()
85, 185	CHANNEL 30	3	C2, C20			ENGINE ARMED——(ON)
85, 185	CHANNEL 30	4	C2, C20			ABORT STAGE——(ON)
85, 185	CHANNEL 30	5	C2, C20			AUTO THROT——(ON)
85, 185	CHANNEL 30	6	C2, C20			DSP INRTL DATA——(ON)
85, 185	CHANNEL 30	7	C2, C20			RR CDU FAIL——(ON)

* Refer to Table 624-200-2.

Title: Quick Look for G&N DOWNLINK Data G&N 711A

Purpose: To provide a prompt print out of the data filed by the G&N Subprogram on the UPLINK file tape.

Calling Sequence:

Entry: This program operates under Executive Control and shall be initiated from the C-START Module.

Data: Input: The data utilized by this subprogram consists of the G&N data filed as DYNAMES on the UPLINK file tape.

Output: The output will consist of the following:

1) Print out of any one file of data

2) Print out of all G&N data starting at a given range time and continuing in increments of one minute to a specified stop time

Normal Exit: Return to Executive Program control

Error Exit: None required.

Computation Sequence:

1) This program will be stored on the master program tape and will be loaded into the ADAP memory section upon initiation from a C-START module.

2) The printout shall be considered low priority and shall not interrupt downlink compressed tape filing or the ACE station displays.

3) The programs shall automatically terminate if any UPLINK commands are transmitted.

4) Upon completion of the print out or emergency termination, the ADAP memory shall be available for other ADAP sequences or load and go programs.

5) The program shall convert the output data from the uplink file tape and print it thru the down link computer. The program shall have the option of utilizing the available downlink compressed data tape drive.

6) The program shall translate DYNAMES records that have been stored by G&N DOWNLINK programs. These are DYNAMES 5 thru 15 inclusive and shall interpret each of these as follows:

TYPE		PRINTER OUTPUT
DYNAMES 5	SYNCERR 1	WDCNT XXX_{10} XXX_8 XXX_8
DYNAMES 6	SYNCERR 2	WDCNT XXX_{10} XXX_8 XXX_8
DYNAMES 7	MARKERR 1	WDCNT XXX_{10} XX_{10}
DYNAMES 8	MARKERR 2	WDCNT XXX_{10} XXX_8 XXX_8
DYNAMES 9	WORDERR 1	WDCNT XXX_{10} XXX_8 XXX_8 XXX_8 XXX_8 XXX_8
DYNAMES 10	WORDERR 2	WDCNT XXX_{10} XXX_8 XXX_8
DYNAMES 11	RELERR 1	WDCNT XXX_{10} XX_8 XX_8
DYNAMES 12	R1 SXXXXX R2 SXXXXX R3 SXXXXX NOUN XX VERB XX PROG XX UX FX	
DYNAMES 13	INO	XX_8
DYNAMES 14	LX WXXX$_{10}$ SX_1X_2 X_N; WXXX$_{10}$ SX_1X_2 ... X_N; N $\leq$ 9	
DYNAMES 15	WORDERR X	WDCNT XXX_{10} XXX_8 XXX_8 XXX_8 XXX_8 XXX_8

Where WDCNT XXX or WXXX is the word number in decimal; the data field for DYNAMES 5, 6, 8, 9, 10, 11, 13, and 15 is octal; the data field for DYNAMES 7, 12, and 14 may be decimal; the sign position for DYNAMES 12 and 14 can be plus, minus or blank.

7) DYNAMES 14 records shall be printed with up to five records per line. The list number will appear only once per line. The DYNAMES 14 records will be printed on the same line provided they are consecutive printable records on the uplink file tape. A new line will be started each time the word number is equal to or less than the previous word number or a record other than DYNAMES 14 appears on the tape.

8) The program shall have the option to ignore DYNAMES types 12 and 14.

Operator Action:

1) The computer room console operator must make the proper C-START entries.

2) The computer room console operator shall notify the test conductor that no uplink activity (except for emergency) shall occur during execution of the program. The program will automatically terminate if any UPLINK activity occurs.

3) Upon completion of the program, the computer room console operator shall notify the test conductor that normal UPLINK activity can be resumed.

APOLLO G&N Specification
ND1002319 REV .K
Original Issue Date:
Release Authority: TDRR 31543
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ACE-S/C COMPUTER SUBPROGRAM

SPECIFICATIONS FOR APOLLO

CM AND LM G & N TESTING

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Date	Revision Letter	TDRR No.	Pages Revised	Approvals AC	Approvals NASA
(H) 7/27/67	H	34236	3, 268, 335, 336, 347, 351,	EA	---
			354, 355, 356, 358, Was 392		
			pages; now 398 pages. ROG/AC		
(M) 8/31/67	J	34461	3, 317, 319, 328, 331, 342, 381,	EA	---
			382 ROG/AC		
9/14/67	K	34608	378, 379	EA	--

This specification consists of page 1 to 398 inclusive.

APPROVALS	NASA/MSC	MIT/IL	AC

Title: ACE-S/C Error Reset Program G&N 671

Part Of: Downlink Program

Purpose: This subprogram resets the error displays on the CRT display unit to give a "no error" indication for the ACE-S/C subprograms utilized with the Block II G&N System.

Calling Sequence: Entry: This subprogram operates under exeuctive control and is initiated from the R-START Module specified in the PRPS or PRD.

Exit: Return to Downlink Executive Program after error displays are reset.

Computation Sequence: The error displays reset by this subprogram are listed below, along with the ACE-S/C subprogram that generates them during its operation. The CRT page and line location for each error display is detailed in the Program Requirements Process Specification.

Error Indication	G&N Program Number
TIME ERROR (1)	601
TIME ERROR (2, 4)	602
TIME ERROR (3)	603
SYNCERR (1, 2)	621, 221, 621-200 or 721
WORDERR (1, 2, 3, 4, 5, 6)	221
RELERR (1)	622, 622-200 or 722
PARERR (1)	631 or 731
KEYERR (1, 2)	631 or 731
VERROR (1, 2, 3, 4, 5)	632 or 732
FSERR (1)	681
WORDERR (1, 2)	621-200 or 721
WORDERR (1, 2, 3, 4, 5, 6, 7,)	621

Each error display consists of a variable segment (underlined) which signifies the type of error condition occurring in a particular ACE-S/C subprogram, and a fixed title segment. When initiated by the operator, this subprogram will blank out the variable segments of the error displays.

This program shall have the option to automatically reset the error displays. This option will be initiated by R-START call as specified in the PRPS or PRD. The program will detect the generation of an error and approximately three seconds later, reset all errors. If another error is generated during the three seconds, the time delay is restarted. At any time the operator may manually reset the errors.

Operator Action: Console Operator: Operator action is required to initiate this subprogram via the R-START module.

Spacecraft Operator: No activity required.

Uplink Requirements: The ACE-S/C Uplink system is not utilized.

Downlink Requirements: PCM data processing is not required by this subprogram.

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ACE-S/C COMPUTER SUBPROGRAM

SPECIFICATIONS FOR APOLLO

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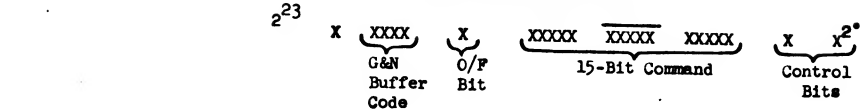
Date	Revision Letter	TDRR No.	Pages Revised	Approvals AC	Approvals NASA
(M) 7/27/67	H	34236	3, 268, 335, 336, 347, 351,	EA	---
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			382 RDG/AC		
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9/21/67	L	34655	354-356, 358 RDG/RC	EA	--

This specification consists of page 1 to 398 inclusive.

APPROVALS	NASA/MSC	MIT/IL	AC

and required control bits as shown below.

G&N UPLINK WORD FORMAT



Prior to transmittal of G&N K-START Uplink words a check is made on the GC discrete "BLOCK UPLINK". If this discrete is "ON" and the R-START "Block Uplink Override" is "OFF", then a "Non-Verify" display will occur on the K-START, the keycode will not be transmitted and a normal system recording will occur on the command tape as specified in Table 631-1. If the "BLOCK UPLINK" discrete is "ON", and the R-START "Block Uplink Override" is "ON", inhibit "Non-Verify" and allow further tests on the incoming keycodes. Each keycode transmitted to the GC when "BLOCK UPLINK" is "ON" and the R-START "Block Uplink Override ON" will be recorded on the Uplink File tape as normal along with the Block Uplink Override R-START Command.

If UPLINK is not BLOCKED, a sequence of tests are made on the incoming keycodes to determine if the command sequence contains a V36. If so, two GC discretes are monitored, namely the "Gimbal Lock" and the "IMU Operate". If both discretes are set to an "ON" state, then a "Non-Verify" display will occur on the K-START and the next keycode will not be transmitted Uplink. Another discrete is monitored, the "Operator Error" flashing discrete. An error status will cause this subprogram to terminate the processing of GC commands by inhibiting further K-START data entry with a "Non-Verify" signal. A normal system recording will occur on the command tape as specified in Table 631-1.

The final discrete tested is UPLOCK, a "ON" state will result in a test for an "alarm reset" keycode. If this code is available, then two commands will be transmitted at the correct frequency. The first command will zero the GC Uplink register and the second, namely, the "reset" keycode will possibly reset the alarm indication triggered by UPLOCK. The "OFF" state for this discrete, will allow the subprogram to continue and transmit the commands to the GC with subsequent recordings on the command tape.

The K-START module is sealed after receipt of a keycode to allow the correct transmission frequence to the GC to be utilized. The sealing can occur as soon as a "good" CSR is received from the DTCS, after which a time delay is utilized to give an approximate maximum input rate to the GC of six keycodes / sec.

A "bad" CSR response should cause the K-START to display a "Non-Verify" and subsequently be unsealed, to allow further operator action to be taken. It should be noted at this point, that as the state of the above mentioned discretes can change at a maximum of only once every second, approximately eight commands could be transmitted Uplink before repeating discrete testing. Figure 631-1 is given as a representative flow, to convey the intent of the subprogram operation.

Operator Action:

During the processing of the input keycodes a test is made to determine whether the range time since "Sealing" the K-START module is greater than or equal to the time delay factor entered via C-START. If so, the verify indication is displayed and the subprogram then transfers control to the Uplink Executive program. If not, the module remains "Sealed" to inhibit further input through the K-START module until the time delay has elapsed. This regulates the input rate of keycodes to the GC. A nominal time delay factor is 90 milliseconds.

Console Operator: Operator action is required to initiate this subprogram by entering data via the K-START module keyboard or tape reader.

When a NON-VERIFY display occurs, further character entry is allowed after depression of the NON-VERIFY switch.

For tape mode of operation enter 3100000XXX into C-START. XXX is the time delay factor in milliseconds.

The operator's responsibility includes the monitoring of displays and the initiation of procedures based upon the display interpretation. Normally the status of the "BLOCK UPLINK" display should be reviewed by the operator prior to insertion of data through the K-START module. However, this K-START subprogram will monitor this discrete, and inhibit any data transfer if this discrete gives an "ON" condition. The "Non-Verify" display which occurs under this condition will then be reset by the operator or inhibited by the R-START, "Block Uplink Override ON". If the "Operator Error ON" condition appears, this subprogram will inhibit data transfer through the K-START with a non-verify. The operator will reset this "Non-Verify" switch and insert a "reset" keycode to clear the "Operator Error" display. Then correct the illegal data sequence and re-enter through the K-START.

An "UPLOCK" display will again inhibit data transfer through the K-START. The operator will reset the "non-verify" and insert a "reset" keycode to clear the discrete. The subprogram will then transmit a "zero" message followed by the "reset" keycode. This may reset the "UPLOCK" discrete and the operator can continue his interrupted sequence of commands by re-inserting the previous keycode.

Two other conditions cause this subprogram to inhibit data input through the K-START, they are a parity error and an invalid keycode. The operator will release the non-verify and apply corrective measures to the input.

If a "Keyerr 2" CRT display occurs, then the operator should re-insert the "Verb 36 Enter" sequence after monitoring the "Gimbal Lock" and "IMU Operate" discrete displays.

Commands inserted via the keyboard will be verified by means of the "closed loop" display, which depicts the GC DSKY status on the CRT, prior to depression of the "Enter" keycodes. The punched tape input, if visual verification is desired, should contain strategically located "stop" codes in the Verb/Noun and parameter sequences, to allow the operator time to perform verification.

Spacecraft Operator: No activity required.

Uplink Requirements:

DTCS Transmission: The data word transmitted to the G&N buffer is identified in the Computation Sequence and will be generated as required.

DTCS Stimuli: None

Transmission Time: During G&N testing this will be specified in the Operational Checkout Procedure. All other times will be as required.

Filing: 1) All K-START command information will be recorded on the Uplink File tape.

2) Additional recordings for error conditions and discrete inhibits are specified in Table 631-1.

3) Each G&N K-START Uplink word transmitted while BLOCK UPLINK is ON will have the R-START number of Block Uplink Override filed with the keycode on the Uplink File tape.

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ACE-S/C COMPUTER SUBPROGRAM

SPECIFICATIONS FOR APOLLO

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ADDRESS Bits 15-12	ACTION
0000, 1111 1111	If 0 or 15_{10} set RELERR to 2, record R11, Relay Word and time lag.
0011, 1001 or 1011	These addresses signify that the special code bit (bit 11) is meaningless, therefore control is transferred to program region 1.
1000	If the address is 8, test bit 11 of the word. If bit 11 is zero, blank the UPLINK activity indicator and go to region 2. If bit 11 is one set the UPLINK activity indicator and go to region 2.
1010	If the address is 10, test bit 11 of the word. If bit 11 is zero, blank the VERB-NOUN FLASH indicator. If bit 11 is one, set the VERB-NOUN FLASH indicator. Following either test go to region 1.
0110, 0100, 0001, 0111, 0101, 0010	If the address is 7, 6, 5, 4, 2 or 1 go to region 3.
1100, 1101, 1110	No processing required, return to EXEC

Region 1 - extracts the relay code corresponding to bits 10 - 6 of the Downlink word and checks it against Table 022-2 for legality. If the code is legal the indicator is set to display the digit from Table 022-2 followed by a transfer to Region 2. If the code is not legal clear the sign display indicator and initiate a relay-error exit.

Region 2 - extracts the relay code corresponding to bits 5 - 1 and checks it against Table 022-2 for legality. If the code is legal the indicator is set to display the digit from Table 022-2 followed by a return to G&N 021. If the code is not legal clear the sign and first digit display indicators and initiate a relay-error exit.

Region 3 - tests the address of the Downlink Word. If the address is 7, 5 or 2 bit 11 is interpreted as follows:

bit 11 = 1	Set sign indicator of R to plus.
bit 11 = 0	If sign indicator is not minus, set sign indicator of R to blank, if minus no change in setting.

C. Insert the first AGC address of the time registers into which the preset value E_p is to be stored, also enter the constant K for G&N 102. This C-START entry is:

1) Windows 10-9 insert 70

2) Windows 8-4 insert YYYYY the 5 digit AGC octal address for the time registers.

3) Windows 3-2 insert XXX milleseconds for K.

The second function of this program is to determine the time to an Epoch and store this time in the AGC.

D. Enter the Epoch time, T_E, that is to be stored in the AGC.

1) Windows 10-9 insert 80

2) Windows 8-5 insert ± XXX hours of T_E

3) Windows 4-3 insert XX minutes of T_E

4) Windows 2-1 insert XX seconds of T_E

E. Enter the AGC octal address, LOC, into which T_E is to be stored.

1) Windows 10-9 insert 71

2) Windows 8-4 insert YYYYY octal address LOC.

3) Windows 3-1 insert 000

F. Call up G&N 101 through R-START Module specified in the PRPS.

Input Data:

T_{R_1} - Range Time maintained in ACE-S/C computer.

E_p - Preset time to be inserted in AGC clock.

T_{RP} - Range time at which E_p is to be inserted.

T_E - Time to Epoch when required.

Normal Exit: Uplink Transmission to the AGC and temporary storage of the following quantities.

K - transmission delays to be supplied jointly by AC and G.E.

T_{HRS} - Range time truncated to hrs.

TABLE 121-3

DOWNLIST 017-1

Position	Block	Position	Block
1	ID (62001)	41	VRECT
2	DSPTAB	42	VRECT +1
3	DSPTAB +1	43	VRECT +2
4	DSPTAB +2	44	VRECT +3
5	DSPTAB +3	45	VRECT +4
6	DSPTAB +4	46	VRECT +5
7	DSPTAB +5	47	TFF
8	DSPTAB +6	48	TFF +1
9	DSPTAB +7	49	TMMARKER
10	DSPTAB +8	50	TMMARKER
11	DSPTAB +9	51	TMMARKER
12	DSPTAB +10	52	DSPTAB
13	DSPTAB +11	53	DSPTAB +1
14	DSPTAB +12	54	DSPTAB +2
15	DSPTAB +13	55	DSPTAB +3
16	TIME 2	56	DSPTAB +4
17	TIME 1	57	DSPTAB +5
18	IN 0	58	DSPTAB +6
19	IN 2	59	DSPTAB +7
20	IN 3	60	DSPTAB +8
21	OUT 1	61	DSPTAB +9
22	STATE	62	DSPTAB +10
23	FLAGWRD1	63	DSPTAB +11
24	FLAGWRD2	64	DSPTAB +12
25	CDUX	65	DSPTAB +13
26	CDUY	66	RN
27	CDUZ	67	RN +1
28	REDOCNTR	68	RN +2
29	DELVX	69	RN +3
30	DELVX +2	70	RN +4
31	DELVX +4	71	RN +5
32	THETAD	72	VN +0
33	THETAD +1	73	VN +1
34	THETAD +2	74	VN +2
35	RRECT	75	VN +3
36	RRECT +1	76	VN +4
37	RRECT +2	77	VN +5
38	RRECT +3	78	PIPTIME
39	RRECT +4	79	PIPTIME +1
40	RRECT +5	80	TIME 2 GR

TABLE 121-3

DOWNLIST 017-1 (Continued)

Position	Block	Position	Block
81	TIME 1 GR	91	VAVEGON +1
82	TCUTOFF	92	VAVEGON +2
83	TCUTOFF +1	93	VAVEGON +3
84	RAVEGON	94	VAVEGON +4
85	RAVEGON +1	95	VAVEGON +5
86	RAVEGON +2	96	TAVEGON
87	RAVEGON +3	97	TAVEGON +1
88	RAVEGON +4	98	TMMARKER
89	RAVEGON +5	99	TMMARKER
90	VAVEGON	100	TMMARKER

TABLE 121-3

DOWNLIST 017-2

Position	Block	Position	Block
1	ID (62067)	24	FLAGWRD 2
2	DSPTAB	25	CDUX
3	DSPTAB +1	26	CDUY
4	DSPTAB +2	27	CDUZ
5	DSPTAB +3	28	-SPARE-
6	DSPTAB +4	29	STCNTR
7	DSPTAB +5	30	STBUFF
8	DSPTAB +6	31	STBUFF +1
9	DSPTAB +7	32	STBUFF +2
10	DSPTAB +8	33	STBUFF +3
11	DSPTAB +9	34	STBUFF +4
12	DSPTAB +10	35	STBUFF +5
13	DSPTAB +11	36	STBUFF +6
14	DSPTAB +12	37	STBUFF +7
15	DSPTAB +13	38	STBUFF +8
16	TIME 2	39	STBUFF +9
17	TIME 1	40	STBUFF +10
18	IN 0	41	STBUFF +11
19	IN 2	42	STBUFF +12
20	IN 3	43	STBUFF +13
21	OUT 1	44	-SPARE-
22	STATE	45	-SPARE-
23	FLAGWRD1	46	-SPARE-

Table 124-012-3

Index No.	Data Word Description	Processing Requirements
30	V_{gy} MSB	None
31	V_{gy} LSB	
32	V_{gz} MSB	
33	V_{gz} LSB	
34	X comp. of sighting vector MSB	
35	X comp. of sighting vector LSB	
36	Y comp. of sighting vector MSB	
37	Y comp. of sighting vector LSB	
38	Z comp. of sighting vector MSB	
39	Z comp. of sighting vector LSB	
40	X comp. of maneuver vector MSB	
41	X comp. of maneuver vector LSB	
42	X comp. of maneuver vector MSB	
43	Y comp. of maneuver vector LSB	
44	Z comp. of maneuver vector MSB	
45	Z comp. of maneuver vector LSB	
46	Desired CDU X	
47	Desired CDU Y	
48	Desired CDU Z	
49	DUMMY MARKER	
50	DUMMY MARKER	
51	DUMMAY MARKER	
52	DSPTAB +0	Display Table Data. Processed by G&N 122.
53	DSPTAB +1	
54	DSPTAB +2	
55	DSPTAB +3	
56	DSPTAB +4	
57	DSPTAB +5	
58	DSPTAB +6	

Title: AGC Downline Interpretation Program G&N 124-017

Part Of: Downlink Program

Purpose: Process for CRT display the data received from the AGC via G&N 121. This program will be used for all test sequences involving the guidance and navigation system for specified vehicles.

Calling Sequence: Entry: This program is activated only by subprogram G&N 121 whenever it has a specified AGC data word available for processing.

Data: Input - A 16-bit AGC word, a word number and a list number from G&N 121.

Output - Information to be displayed on the CRT.

Normal Exit: None.

Computation Sequence: Table 124-017-1 defines all computation and special handling required. If a word number does not appear for a list, no processing is required by this program for that word in that list.

Operator Action: Control Room: No action required.

Spacecraft: No action required.

Uplink Requirements: DTCS transmission: None

DTCS Stimuli: None

Time of Transmission: None

Filing Requirements: None

Downlink Requirements:

Measurement ID: The data processed by this subprogram is derived from CG0001

CRT Display: Defined in the Table 124-017-1. Fixed CRT annotation and the page and line information is in PRPS document for a particular vehicle.

Tolerance: None

Filing Requirements:

Activation of the "RECORD" R-START module function switch specified in the PRPS will cause the recording of the ID and a time tag plus the following:

Discrete Words: DSPTAB + 11, DSPTAB + 13, OUT 1, STATE, FLAGWORD 1, FLAGWORD 2, IN0, IN2, IN3

Single Precision Words:

CDUX, CDUY, CDUZ, RE DO CNTR

Double Precision Words:

(TIME2, TIME1), (TFF, TFF + 1), (TCUTOFF, TCUTOFF + 1), (TIME2GR, TIME1GR)

Title: K-START Module Program G&N 131

Part Of: Uplink Program

Purpose: This subprogram accepts data input in the form of AGC keycodes from the punched tape reader or the keyboard, via the K-START module. These keycodes are checked for correct parity and valid codes and then formatted into a command word for eventual transmission to the External DTCS. The status of the Uplink system and the AGC is monitored, and the Uplink command sequence is controlled, to the acceptable input rate of the AGC.

Calling Sequence: Entry: This subprogram operates under Uplink Executive Program control and will be initiated from K-START module specified in the PRPS.

Data: This consists of information received either from K-START puched tape, (the automatic mode) or from the K-START keyboard (the manual mode). The data content utilized by this subprogram consists of a five bit keycode plus a parity level.

Normal Exit: Return to Uplink Executive Program.

Error Exit: Error conditions will be displayed for the operator on the CRT and recorded on the Uplink Command Tape. These error conditions are subsequently described in Table 131-1.

The flow chart Figure 131-1 is given as a representative flow, to convey the intent of the sub-program operation. Table 131-2 lists the legal AGC keycodes.

Operator Action:

Console Operator: Operator action is required to initiate this sub-program by entering data via the K-START module keyboard or tape reader.

When a NON-VERIFY display occurs, further character entry is allowed after depression of the NON-VERIFY switch.

The operator's responsibility includes the monitoring of displays and the initiation of procedures based upon the display interpretation. Normally, the status of the "Accept Uplink" CRT display should be reviewed by the operator prior to insertion of data through the K-START module. However, this K-START subprogram will monitor this discrete bit, and inhibit any data transfer if this discrete gives an "OFF" condition. The "non-verify" display which occurs under this condition will then be reset by the operator.

If a "T/M Fail ON" indication appears, this subprogram will halt further data input through the K-START. The operator should reset the "non-verify" switch and insert an "error reset" keycode.

The subprogram will then transmit a "zero" message followed by the "error reset". This may reset the "T/M Fail" indication, and the operator can continue his interrupted sequence of commands, by re-inserting the previous keycode.

Normally the "Check Fail" discrete should be monitored by the operator, however, the subprogram will perform this check prior to Uplink transmission of a keycode. If this discrete is "ON" then the "non-verify" will be displayed to signify that the operator should monitor the discrete. The operator should reset the non-verify switch and insert an "error reset" keycode to clear this discrete display.

Commands inserted via the keyboard will be verified by means of the "closed loop" display which depicts the AGC DSKY status on the CRT, prior to depression of the "ENTER" keycodes. The punched tape input, if visual verification is desired, should contain strategically located "stop" codes in the Verb/Noun and parameter sequences, to allow the operator time to perform verification.

Title: EXECUTIVE SEGMENT

Purpose: The purpose of the Executive Segment is to prepare the Edit Parameters for use by the Presentation Segment, processes the Control Cards, and to extract and validate the required CGC/LGC data from the PCM Data Tape.

Input: The inputs to this segment are:

1) Downlink Edit Format and Requirements Tables (Edit Parameters)
2) Data Definition, Title and Time Cards (Control Cards)
3) PCM Data Tape or CDT containing the CGC/LGC data to be processed.

Output: The outputs from this segment are:

1) Edit Parameters for use by the Presentation Segment
2) CGC/LGC data extracted from the PCM Data Tape or CDT
3) Error signals for any discrepancies found in the Edit Parameters, the Control Cards, and the CGC/LGC data.

Normal Exit: The normal exit from this segment is to the Presentation Segment. The normal program halt occurs when the last time interval has been satisfied.

Error Exit: Error signals are generated for discrepancies found in the Input Cards, PCM or CDT Data. The Error Exit is to the Presentation Segment.

Description: The CGC/LGC data consists of two types of words:

1) Identification Words (2): These words indicate the type of downlink transmission (List) and signal the start of the data transmission.
2) Data Words (98): Actual CGC/LGC words. The position of a data word in a List identifies its content. There is a unique Word Order Code associated with each type of word.

The first card to be input is the Data Definition Card. This card identifies the position of the CGC/LGC words in a Prime Frame of PCM Telemetry Data.

The List being sent changes during the various phases of a mission program. A set of Edit Parameters is required for each List. The number of Lists to be used during the missions utilizing Block II Computers is not known; as a preliminary estimate, this program should be able to accomodate up to twenty different lists.

A set of Edit Parameters for any List will consist of:
1) LIST ID card - This card contains the bit configuration (in octal) of the ID Words of the List for which the tables following this card are to be used.

2) R cards - These cards define the print format of the data for the particular list.

3) ENG card - These cards define the English phrase interpretations for the particular List.

4) E Cards - These cards define the processing requirements for the particular list.

5) END Card - This card is the last card of the set of Edit Parameters for the particular List.

This sequence of cards will be repeated for each List.

Run cards to be input with each run will consist of:

1) G&N card - This card will contain the description of the particular run and will be used as a page heading on the output listing.

2) TIME cards - These cards will designate the data to be processed. Each card will contain a start and a stop time in hours, minutes, and seconds. If more than one TIME card is used, the times specified will not overlap and will be in sequence.

3) END OF RUN card - signals the end of the Control Cards.

Appropriate validity checks should be made on the format of these cards. Any card error will suspend the processing of and PCM or CDT Data, but all cards should be scanned and all errors displayed even though no data will be processed.

Usage of the Downlink Edit Program - Block I has shown that the Edit Parameters tend to be fixed once the data content of the Downlink is known. New sets of Edit Parameters will be used only for special applications. The Executive Segment should process the Downlink Edit Format Tables and the Downlink Requirements Tables and save them on tape so that subsequent runs with the same type of data may be made with no reprocessing of those cards.

Time: There is a time signal on the PCM Data Tape and the CDT and the time of transmission of each CGC/LGC word can be determined. This time is matched to the time intervals requested to determine what data is to be processed. Data should be processed from the first ID following the start time to the end of the Downlist after the stop time. The time occurance of the ID Word must be available to the Executive Segment.

Data Form: The CGC/LGC transmitts blocks of five 8 bit words into the PCM stream of telemetry. These forty bits contain the data to be processed. Fifty of these blocks represent a complete cycle through a Downlink List. The Downlist consists of a fixed length of 100 CGC/LGC words, each block representing 2 of these words. The first block of a Downlist contains the ID Words. These words identify the List being transmitted. Following the ID Words are 98 Data words CGC/LGC words are 16 bits in length and are configured as:

S/15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 P

where: bit 15 is the Sign bit for numeric data bits 14 thru 1 are the data bits for numeric data P is the Parity (Odd) bit.

Validation: The Validity checks to be made on the CGC/LGC data are:

1) Check - Out of Sync signaled by DECOM
Action - Message SYNCERR1, indicate which words are out of sync but process anyway.

2) Check - Over ninety-eight data words since ID words
Action - Message SYNCERR2, process first ninety-eight data words and ignore the rest until ID words received.

3) Check - ID Words received before ninety-eight data words were received since last ID Words.
Action - Message SYNCERR3, process data words received begin next Downlist with new ID Words.

4) Check - Parity incorrect in first CGC/LGC word in block
Action - Message WORDERR1, display the 40 bits in Octal and the index number. Do not process the word in error.

5) Check - Parity incorrect in second CGC/LGC word in block
Action - Message WORDERR2, display the 40 bits in Octal and the index number. Do not process the word in error.

6) Check - First ID Word, bits 15 to 11 Invalid
Action - Message WORDERR3

7) Check - First ID Word, bits 10 to 1 Invalid
Action - Message WORDERR4, Invalid ID, display the 40 bits in octal and the index number. Cycle until next ID received.

8) Check - Second ID Word Invalid
Action - Message WORDERR5, display 40 bits in octal. If no error was found in the first ID Word, the ID will be considered Valid and ID word 1 will be used to determine the list being sent.

NOTE: WORDERR3 alone will not invalidate the ID. If no other ID errors are found, bits 10 to 1 of ID word 1 will determine the list being sent.

TITLE: PRESENTATION SEGMENT

Purpose: The Presentation Segment receives the 16 bit COC/LOC words from the Executive Segment. These words are processed in the manner defined by the Downlink Requirements Tables and displayed in the manner defined by the Downlink Edit Format Tables.

Input: The inputs to this segment are:
1) Edit Parameters and ID Word configurations for all Downlists to be processed.
2) The 16 bit COC/LOC Words.
3) Error indicators associated with the 16 bit words transmitted.

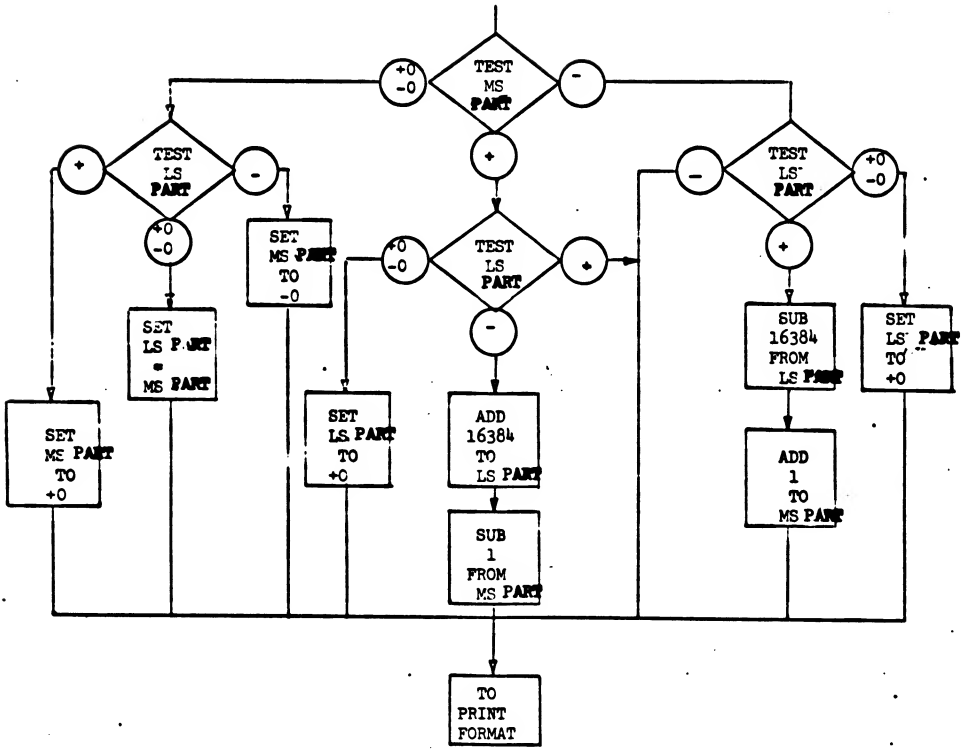
Output: The output from this segment is the printed listing in the formats defined by the Edit Parameters and any error messages generated.

Exits: The normal and the error exits from this segment are to the Executive Segment.

Description: This segment receives the 16 bit COC/LOC words and any error signals from the Executive Segment. Each word is examined to determine if it is on ID Word or a Data Word. When the ID Words are received, the time of their occurance is printed as positioned by an E card. The Edit Parameters for data following the particular ID are made ready for processing. The ID words may be processed as data words for printing. When Data Words are received, a check of the Edit Parameters will determine if the word is to be used, and if so, how to process it. Error signals generate output messages. All COC/LOC words are treated as binary fractions with the binary point between the 15th and 14th bits of the word. Double Precision quantities will require that processing be held up until both words have been received.

Note that the most significant part and the least significant part of a double precision word do not necessarily have the same sign. Use the following diagram for a processing technique.

Method For Handling Double Precision Words:



Card Formats:

Data Definition Card - This card locates the two sixteen bit CGC/LGC words and the Word Order Code (WOC) contained in the 40 bits defined. This card also will define the representative WOC bit for ID Words. That is, the bit (0 or 1) indicated will be in each bit position of the WOC for ID Words. The 5-8 bit words will be considered as individual bits numbered 1 to 40 with the left most bit of the first word called bit 1 and numbered consecutively to the right most bit of the fifth word, bit 40.

Columns	Contents	Comments
1 to 4	DATA	defines card type
9 to 11	PCM	comment
22 to 25	WRD1	comment
27 to 31	XX-XX	first and last bit position of CGC/LGC word 1
34 to 37	WRD2	comment
39 to 43	XX-XX	first and last bit position of CGC/LGC word 2
46 to 48	WOC	comment
50 to 54	XX-XX	first and last bit position of word order code
57 to 61	IDWOC	comment
63	X	WOC representative bit for ID Words

Comments need not be checked for. The CGC/LGC words should be 16 bits in length, the word order code may be from 1 to 8 bits. All WOC bits will be identical if more than one is specified. The representative WOC bit for ID words is supplied. Data word WOC is assumed to be the complement of the ID WOC. See card example page for further clarification.

Downlink Edit Format Tables: A Downlink Edit Format Table is required for each Downlist to be processed. This table specifies the fixed format layout of the edit listing. A field width of 120 print characters is required. The spacing alloted between the title entries of this table is for the insertion of the CGC/LGC data as processed by the Presentation Segment. This table is composed of R cards. These cards provide the titled entries for the edit listing. No more than two cards are used to define any single line of the listing. The set of R cards for any Downlist will not define over 50 lines including spacing.

Columns	Contents	Comments
1	R	defines card type
6, 7	XX	line sequence number
8	y	print control
9 to 80		fixed format layout

where: XX R cards for a particular List are in sequence by this number. This number is used by the E cards to identify the lines on which the processed data will be displayed.

y = blank or 1, skip one line after printing
= 2, skip two lines after printing
= 9, fixed format layout of this card is the right most poriton of the previously defined line

If y is blank, 1, or 2, columns 9 thru 80 of the card will be printed in print positions 1 to 72.
If y is 9, columns 9 thru 56 will be printed in print positions 73 to 120.

Downlink Requirements Tables:

A Downlink Requirements Table is needed for each Downlist to be processed. This table defines the specific entries required for the edit listing by referencing the index number (word position in Downlist) of the words to be processed. This table specifies the exact placement, in terms of print positions, of each data entry in the fixed edit format defined by the Downlink Edit Format Table for this Downlist. This table also specified the processing required for each data entry in the output. A Downlink Requirements Table is composed of E cards and ENG cards.

Columns	Contents	Comments
1	E	defines card type
9, 10	XX	line number (match to R card line sequence number)
12 to 18	XXX-XXX	print positions in output line where this entry is to be displayed.
25 to 30	EQUALS	
32 to 34	XXX	index number (001 to 100)
	For quantitites to be displayed in decimal	
36 to 62	DP or SP (Double or Single Precision), Scale Factor (sign, decimal point, one to ten decimal digits), power (E, sign, one or two decimal digits), S or NS (if S, print sign; if NS treat word as 15 bit unsigned number), MSB (for double precision, indicates most significant bits)	
	For other quantitites	
36 to 50	XX or XX-XX or XX,XX-XX (bit positions to be considered - leading zeros not supplied) OCTAL (print bits indicated in octal) or BINARY (print bits indicated in binary) or ENGn (Extract bits indicated and search English table specified for match and insert associated phrase in output), I or blank (I, if bit 15 of the word is a 1, the bits indicated must be complimented before processing; if field is blank or if bit 15 is 0, the bits indicated are used as is).	
	Fields will be seperated by commas, and except where mentioned, lead zeros will be supplied.	

The ENGn cards contain English phrases to inserted in the output listing when certain combination of bits are present in key CGC/LGC words. The bits for comparison and the table to be searched are indicated by E cards.

Columns	Contents	Comments
1 to 3	ENG	defines card type
4	n	table number (n = 1 to 8)
8 to 23	1 to 16 binary characters that is the bit pattern for which the English phrase will be substituted (bits specified n in E card are extracted and compared to the non-blank columns - right justified to column 23)	
25 to 30	EQUALS	
33 to 53	1 to 20 alphanumeric characters to be inserted in print positions defined in the E card - left justified to column 33. A $ in column 33 means that no phrase is to be inserted for the bit pattern matched.	

Downlink Requirements Tables:

If the designated ENGn table is searched and no match is found, an error condition exists. A message, DOWNERR1 is printed along with the index number of the word that contained the bits that could not be matched and the word (16 bits) in octal.

NOTE:

A special application of the E card will be used to position the time of the ID word in the edit listing. Index word 000 will indicate this time and it will be positioned in the normal manner. E.G.
E 06,018-037 EQUALS 000
Print GMT on the line defined by R 06 in print positions 018 through 037. The processing requirements for this word are already defined.

List Identification Card - This card is the first card of the set of Edit Parameters for a particular Downlist. The bit configurations of the ID Words, whose data will be processed according to the tables following this card, are contained in this card.

Columns	Contents	Comments
1 to 4	LIST	defines card type
7 to 12	XXXXXX	bit configuration in Octal of first ID word
15 to 20	XXXXXX	bit configuration in Octal of second ID word

The 16 binary bits are converted into 6 octal characters by adding two binary zeros to the right to make 18 binary bits E.G. (1100100001101111) will be in the card as 620674.

End Card - This card is the last card of the set of Edit Parameters for a particular Downlist.

Columns	Contents	Comments
1 to 3	END	defines card type

The Edit Parameters for each Downlist consist of: LIST ID card, R cards, ENGn cards, E cards and the END card in that order.

Cards Input for each run: The page title card contains the run description, date, OCP, etc, and is printed once per page.

Columns	Contents	Comments
1 to 3	G&N	defines card type
5 to 75	page title	to be printed as the first line of each page.

The data to be processed are defined as a set of 1 to n time intervals. Each card contains the start and stop time of a data interval. For multiple intervals, the times will not overlap and will be in sequence.

Columns	Contents	Comments
1 to 4	TIME	defines card type
6, 7	XX	start time, hours
8, 9	YY	start time, minutes
10, 11	ZZ	start time, seconds
13, 14	TO	
16, 17	XX	stop time, hours
18, 19	YY	stop time, minutes
20, 21	ZZ	stop time, seconds

The last card to be input is the End of Run card.

Columns	Contents	Comments
1 to 10	END OF RUN	defines card type

Example 1 E 02, 018-026 EQUALS 062,DP,+.16777528E+5,S,MSB

E - specifies requirements equals card
02 - specifies the number of a R card entry in the Edit Format table which designates the line that this data is to be printed on.
018-026 - specifies the print positions of line 02 that this data is to be printed in
062 - specifies the position in the Downlink List (index number) that contains the data to be processed.
DP - specifies that the data is double precision
+.16777528 - specifies the numeric value of the scale factor
E+5 - specifies the power of the scale factor
S - specifies the data is a signed number
MSB - specifies that word 062 is the most signifient bits of the double precision quantity.

This card requires that the 14 data bits of word 062 and the 14 data bits of word 063 be combined as previously described into a 28 bit binary fraction, converted to a decimal fraction, multiplied by 16777.528 and printed in positions 018 to 026 of line 02.

Example 2 E 61,047-062 EQUALS 029,7,5-1,ENG2

E - specifies requirements Equals card
61 - specifies the number of the R card entry
047-062 - specifies the print positions of R 61 for display
29 - specifies the eindex number of the data
7,5-1 - specifies the bits to be extracted from word 029
ENG2 - specifies the table of English phrases that is to be searched for the same pattern of the bits extracted.

This card requires that bits 7 and 5 thru 1 be extracted from word 029. These bits are then compared to the patterns that are part of English phrase table ENG2. When the bits are matched, the English phrase associated with that pattern is printed in print positions 047 to 062 of the line defined by R card 61.

Example 3 E 04, 109-109 EQUALS 012,6,BINARY

E - specifies requirements Equals card
04 - specifies the number of a R card entry
109-109 - specifies the print position on line defined by R04
012 -specifies the index number of the data
6 - specifies the bit position to be extracted from word 12
BINARY - specifies that the bit be displayed in binary.

Example 4 E 06,097-112 EQUALS 026,15-1,OCTAL

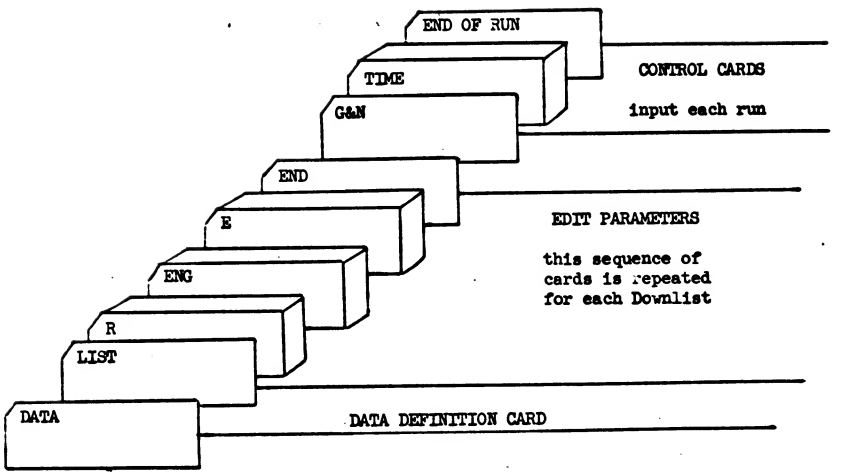
E - specifies requirements Equals card
06 - specifies the R card line number
097-112 - specifies the print position in the line defined by R 06
026 - specifies the index number of the CGC/LGC data
15-1 - specifies the bits of word 012 to be processed
OCTAL - specifies that the data is to be printed in octal

Example 5 ENG2 001001 EQUALS FINE ALIGN

ENG2 - specifies requirements English card
001001 - specifies the bit pattern that will be interpreted by the english phrase
FINE ALIGN - specifies the message that is to be printed in the print positions called out by the E card that refers to the ENG2 table.

This card is actually a sub-card to an E card. The E card specifies the bits of a CGC/LGC word to be compared to the various entries of the ENG2 table and the print positions for the message.

Input Card Deck Makeup:



Input Card Examples:

```
DATA  PCM     MRBII 002-117 MRBII 115  33  MSC 01-01  IDMSC 11
LIST  01162154 00043374
R     0122AGC TIME          HRS  IMU MODE              AGC ID
ENGI2                 00110001 EQUALS  ZERO ENCODER
E     02,0118-0126            EQUALS  016,DP,+.7456,5404124E+3,S,MSB
E     45,0141-0120            EQUALS  025,SP,+-.180E+3
E     53,0138-0154            EQUALS  020,7,5-1,ENG2,I
E     05,0140-0140            EQUALS  013,+1,PRIMARY
E     05,0119-0123            EQUALS  013,+15-1,OCTAL
END   COMPRESSED TIME  MISSION SIMULATION  AS-202  OCP-K00335  6/6/66
G+N   14553119 T4 1153220
TLM   RUN
ENE
```

References: 1) AC Electronics Diagnostic Program Specification for CMC Block I (CMCD1) - G&N Downlink Edit, Block I

2) MIT/IL STG MEMO 560 - ACE S/C Subprogram Specification for the Downlink Format Program, LGC Block II (G&N 621)

3) MIT/IL STG Memo 488 - ACE-S/C Subprogram Specification for the ACE G&N Downlink Edit Program (G&N 010)

Title: GC Downlink Format Program, Block II G&N 221

Part Of: Downlink Program

Purpose: The GC transmits blocks of five 8-bit words (time slots 32-36) into the PCM T/M at a 50 block per second rate. These data blocks represent a complete cycle through one GC Downlist. The Downlist consists of a fixed length of 100 GC words, each data block representing 2 of these words. The list address contained in the ID word identifies the transmitted parameters.

The Downlink Format subprogram accepts each block of five 8-bit words, verifies parity, and reformats each word into a 16-bit format. The type of GC word represented is identified and the word is routed to other ACE-S/C subprograms for subsequent processing.

Calling Sequence: Entry: This subprogram operates under Downlink Executive Program control and is initiated by receipt of an Executive program interrupt.

Data: 1) A sequence of 50 blocks of five 8-bit words during 1 second.

2) Notification upon loss of a block (prime frame) or sequence of 50 blocks (sub-frame).

Normal Exit: Valid data is transmitted to the appropriate ACE-S/C subprogram for further processing and display.

Error Exit: Error conditions will be displayed on the CRT. A search for an ID word to enable further data processing, occurs under certain error conditions. The CRT error displays are detailed in Table 221-1.

Computation Sequence:

The program receives blocks of five 8-bit words, configured as follows:

WORD 1	WOC	S/15	14	13	12	11	10	9
WORD 2	8	7	6	5	4	3	2	1
WORD 3	P	S/15	14	13	12	11	10	9
WORD 4	8	7	6	5	4	3	2	1
WORD 5	P	X	X	X	X	X	X	X

where WOC = Word order code (1 bit)
P = Odd parity (GC word)
X = 0 as presently configured

The data block contains 2 GC 16-bit data or DSPTAB words, except where an ID word is encountered. The individual word formats are specified below. The GC data word includes a parity (P) and sign (S) bit. (See Figure 221-1.)

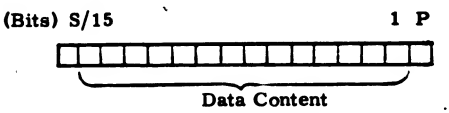
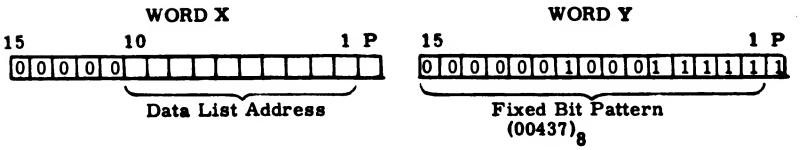


Figure 221-1

The DSPTAB word format is essentially as specified in Figure 221-1, as far as this program is concerned.

The identification (ID) word format contains five leading zeros with bits 1-10 containing the data list address. The complete ID word format is:



Word X precedes Word Y in the data block transmittal (Word 1 - Word 5). The Word order code (WOC) bit contains a 1 for all data and DSPTAB words, and a 0 for the ID word. The position of the LGC word in the fixed length list determines whether the word is to be processed for data monitoring or for DSKY display monitoring. The specified Downlink lists which initiate the operation of this program are contained in G&N 224, Table 224-1.

Basically, Program G&N 221 receives PCM data blocks, checks parity, and determines the word type, to allow the transfer of 16-bit words to ACE-S/C programs for subsequent processing. A word count is utilized to detect any deviation from the normal list transmission. A block count is also utilized to indicate if both words in the data block have been processed and so allow the reading in of another block.

When an error is sensed, display and recording of pertinent information takes place and depending upon the type of error, control is transferred to point C in the flow chart (Figure 221-2) where a search for an ID word is initiated.

If a DSPTAB word is detected, then bit 15 is checked for a '1' indication. If a '1' is encountered the word must be complemented prior to transmitting the word to G&N 622 for further processing. Upon detection of an ID word, the data list address is transmitted to G&N 224 to allow that program to utilize the correct display format and scaling information. Figure 221-2 is given as a representative flow, to convey the intent of the subprogram operation.

Operator Action:	Console Operator: No activity required.
Spacecraft Operator:	No activity required.
Uplink Requirements:	Not applicable.
Downlink Requirements:	
	Display: This information is detailed in the flow chart and consists of program error displays as specified in Table 221-1. The ACE requirements specification contains the CRT page and line information.
References:	ACE-S/C Computer Subprogram, G&N 224 Downlink Interpretation Program.

TABLE 221-1

Error Description	CRT Display
This indicates that Wordcnt has incremented beyond a specified limit.	SYNCERR 1
At this point Wordcnt should be 101, if an ID has been received in the correct sequence.	SYNCERR 2
Parity is incorrect in the first LGC word in data block.	WORDERR 1
Parity is incorrect in the second LGC word in data block.	WORDERR 2
ID word (bits 11 - 15) $\neq (00)_8$	WORDERR 3
Fixed bit pattern in ID word is illegal.	WORDERR 4
Invalid list address encountered after attempting to utilize second LGC word to identify ID word.	WORDERR 5
Invalid list address encountered in the first LGC word in data block.	WORDERR 6

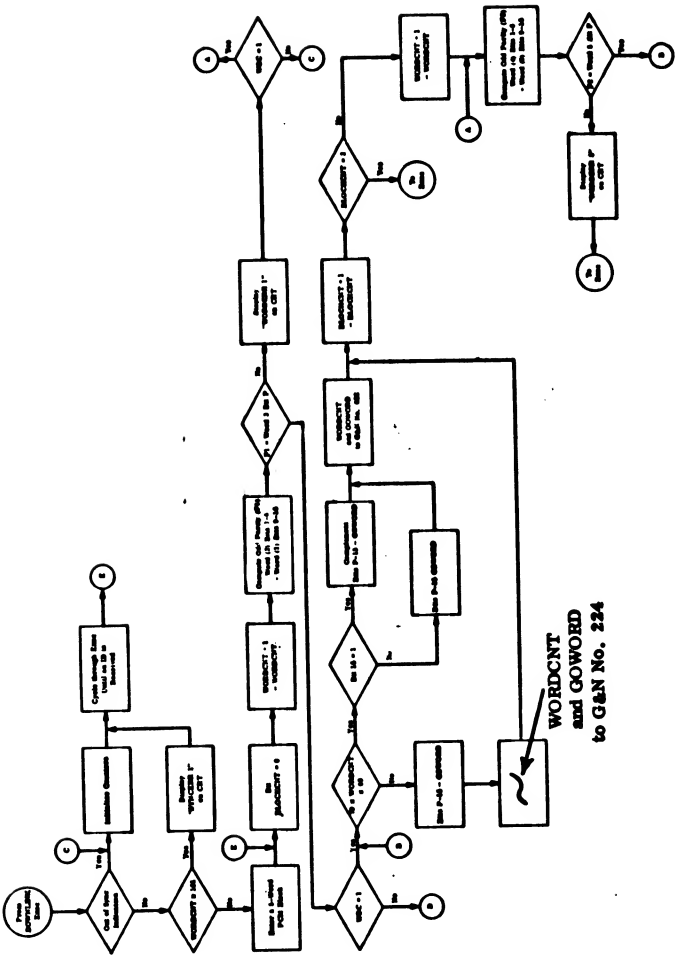


Figure 221-2 (1 of 2)

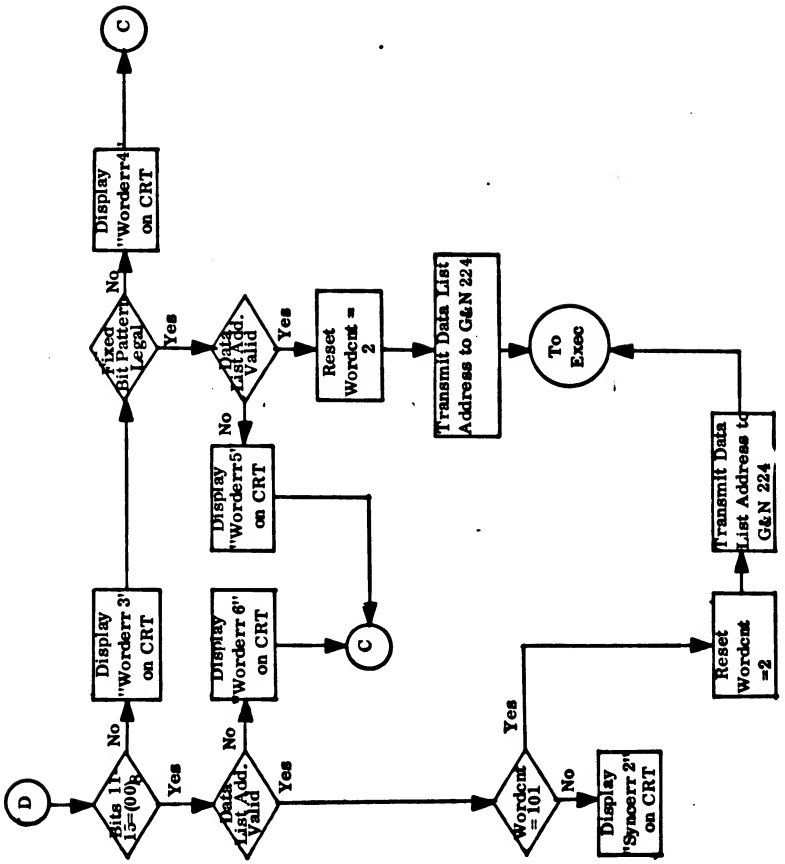


Figure 221-2 (2 of 2)

Title: GC Downlink Interpretation Program, Block II G&N 224

Part Of: Downlink Program

Purpose: This subprogram defines the interpretation of the GC Downlink data which is required for ACE-S/C console operator usage and information. The processing requirements for the Nominal GC Downlink list for SUNDIAL is included in this document.

Calling Sequence: Entry: This subprogram is activated by the GC Downlink Format Program, G&N 221 whenever the Format Program is processing Downlink data.

Data Input: Input from G&N 221 to the Downlink Interpretation Program consists of a 16-bit GC data word stored in the computer. Two types of GC words will be processed by G&N 224:

1) Identification: This word specifies the data list which is being received by G&N 221.

2) Data: Actual GC data words. The position in the list identifies the data being processed.

Data Output: Output will consist of CRT displays and processed parameters stored in temporary buffers for use by other ACE-S/C G&N subprograms.

Normal Exit: Return to ACE Executive Program which will supply more data to G&N 221.

Error Exit: None

Computation Sequence: The Nominal Downlink List for the GC is transmitted once per second and consists of 100 words (two per prime frame).

Table 224-1 describes the contents of the List and provides the processing requirements for each word.

Operator Action: Console Operator - No activity required.

Spacecraft Operator - No activity required.

Uplink Requirements:

No stimuli required.

Downlink Requirements:

Data Manipulation - Found in the computation sequence section.

CRT Display - The ACE Requirements Specification contains the CRT scope page and line information.

Filing Requirements: None

Table 224-1
Nominal GC Downlink List

Word NO.	Word Name	G&N 224 Processing Requirements
1	01724	None
2	00437	None
3	PIPAX	Defined in Table 224-2
4	PIPAY	Defined in Table 224-2
5	PIPAZ	Defined in Table 224-2
6	BMAGX	Defined in Table 224-2
7	BMAGY	Defined in Table 224-2
8	BMAGZ	Defined in Table 224-2
9	PUSHLOC	None
10	PRIORITY	None
11	LOC	None
12	BANKSET	None
13	DELVX	None
14	DELVX+1	None
15	DELVX+2	None
16	DELVX+3	None
17	DELVX+4	None
18	DELVX+5	None
19	SELFRET	None
20	SMODE	None
21	SFAIL	None
22	ERCOUNT	None
23	IMODES30	Defined in Table 224-2
24	IMODES33	None
25	DESOPTT	None
26	DESOPTS	None
27	CDUX	Defined in Table 224-2
28	CDUY	Defined in Table 224-2
29	CDUZ	Defined in Table 224-2

Table 224-1 (Continued)

Word No.	Word Name	G&N 224 Processing Requirements
30	CDUT	None
31	CDUT	Defined in Table 224-2
32	CDUS	Defined in Table 224-2
33	STATE	None
34	STATE+1	None
35	STATE+2	None
36	STATE+3	None
37	REDOCTR	Defined in Table 224-2
38	FAILREG	Defined in Table 224-2
39	OPTMODES	Defined in Table 224-2
40	SWSAMPLE	None
41	DESOPMOD	None
42	WTOPTION	None
43	IMUCADR	None
44	OPTLADR	None
45	THETAD	None
46	THETAD+1	None
47	THETAD+2	None
48	DESOPTT	None
49	MARKSTAT	None
50	TIMESAV	None
51	DRIFTO	Defined in Table 224-2
52	DRIFTO+1	None
53	DRIFTI	Defined in Table 224-2
54	DRIFTI+1	None
55	DRIFTT	Defined in Table 224-2
56	DRIFTT+1	None
57	GAZIMUTH	Defined in Table 224-2
58	GAZIMUTH+1	None
59	ANGZ	Defined in Table 224-2
60	ANGZ+1	None

Table 224-1 (Continued)

Word No.	Word Name	G&N 224 Processing Requirements
61	ANGY	Defined in Table 224-2
62	ANGY+1	None
63	ANGX	Defined in Table 224-2
64	ANGX+1	None
65	VLAUN	None
66	VLAUN+1	None
67	WPLATO	None
68	WPLATO+1	None
69	WPLATI	None
70	WPLATI+1	None
71	WPLATT	None
72	WPLATT+1	None
73	PIPAN	Defined in Table 224-2
74	INTVEC+1	None
75	PIPAE	Defined in Table 224-2
76	INTVEC+3	None
77	UPLOCK	Defined in Table 224-2
78	TGLOC	None
79	DSPTAB+0	None
80	DSPTAB+1	None
81	DSPTAB+2	None
82	DSPTAB+3	None
83	DSPTAB+4	None
84	DSPTAB+5	None
85	DSPTAB+6	None
86	DSPTAB+7	None
87	DSPTAB+8	None
88	DSPTAB+9	None
89	DSPTAB+10	None
90	DSPTAB+11	Defined in Table 224-2

Table 224-1 (Continued)

Word No.	Word Name	G&N 224 Processing Requirements
91	TIME2	Defined in Table 224-2
92	TIME1	Defined in Table 224-2
93	CHANNEL 11	Defined in Table 224-2
94	CHANNEL 12	Defined in Table 224-2
95	CHANNEL 13	Defined in Table 224-2
96	CHANNEL 14	None
97	CHANNEL 30	Defined in Table 224-2
98	CHANNEL 31	Defined in Table 224-2
99	CHANNEL 32	Defined in Table 224-2
100	CHANNEL 33	Defined in Table 224-2

TABLE 224-2

WORD NO.	WORD NAME	BITS	DATA MANIPULATION See Notes (-)	DISPLAY	SCALE FACTOR
3	PIPAX	1-15	CONVERT TO DECIMAL	PIPAX±XXXXX	1
4	PIPAY	1-15	CONVERT TO DECIMAL	PIPAY±XXXXX	1
5	PIPAZ	1-15	CONVERT TO DECIMAL	PIPAZ±XXXXX	1
6	BMAGX	1-15	CONVERT TO DECIMAL	BMAGX±XXXXX	1
7	BMAGY	1-15	CONVERT TO DECIMAL	BMAGY±XXXXX	1
8	BMAGZ	1-15	CONVERT TO DECIMAL	BMAGZ±XXXXX	1
23	IMODES30	1	(a)	IGN PIP FAIL ON (OFF)	N/A
23	IMODES 30	2	NONE	N/A	
23	IMODES30	3	(a)	IGN ICDU FAIL ON (OFF)	N/A
23	IMODES30	4	(a)	IGN IMU FAIL ON (OFF)	N/A
23	IMODES30	5	NONE	N/A	N/A
23	IMODES30	6	(a)	INITIALIZE ISS ON (OFF)	N/A
23	IMODES30	7-15	NONE	N/A	N/A
27	CDUX	1-15	CONVERT TO DECIMAL	CDUX±XXX. XX DEG	$180°/2^{14}$
28	CDUY	1-15	CONVERT TO DECIMAL	CDUY±XXX. XX DEG	$180°/2^{14}$
29	CDUZ	1-15	CONVERT TO DECIMAL	CDUZ±XXX. XX DEG	$180°/2^{14}$
31	CDUT	1-15	CONVERT TO DECIMAL	CDUT±XX. XXX DEG	$45°/2^{14}$
32	CDUS	1-15	CONVERT TO DECIMAL	CDUS±XXX. XX DEG	$180°/2^{14}$
37	REDOCTR	1-15	CONVERT TO DECIMAL	REDOCTR XXXXX	$180°/2^{14}$
38	FAILREG	1-15	DISPLAY IN OCTAL	FAILREG XXXXX	N/A
39	OPTMODES	1	NONE	N/A	N/A
39	OPTMODES	2	(a)	IGN OCDU FAIL ON (OFF)	N/A
39	OPTMODES	3	(a)	OPT ZEROING ON (OFF)	N/A
39	OPTMODES	4-5	(c)	OPT SWITCH XXX	N/A
39	OPTMODES	6-15	NONE	N/A	N/A
51	DRIFTO	1-15	CONVERT TO DECIMAL	V DRIFTO±XXX. XX MERU	$1000/2^{14}$
53	DRIFTI	1-15	CONVERT TO DECIMAL	S DRIFTI±XXX. XX MERU	$1000/2^{14}$
55	DRIFTT	1-15	CONVERT TO DECIMAL	E DRIFTT±XXX. XX MERU	$1000/2^{14}$
57	GAZIMUTH	1-15	CONVERT TO DECIMAL	GAZIMUTH±. XXXXX	$1/2^{14}$
59	ANGZ	1-15	CONVERT TO DECIMAL	ANGZ±. XXXXX	$1/2^{14}$

TABLE 224-2 (Continued)

WORD NO.	WORD NAME	BITS	DATA MANIPULATION See Notes (-)	DISPLAY	SCALE FACTOR
61	ANGY	1-15	CONVERT TO DECIMAL	ANGY±. XXXXX	$1/2^{14}$
63	ANGX	1-15	CONVERT TO DECIMAL	ANGX±. XXXXX	$1/2^{14}$
73	PIPAN	1-15	CONVERT TO DECIMAL	PIPAN±XXXXX	1
75	PIPAE	1-15	CONVERT TO DECIMAL	PIPAE±XXXXX	1
77	UPLOCK	1	(a) (d)	UPLOCK ON (OFF)	N/A
77	UPLOCK	2-15	NONE	N/A	N/A
90	DSTAB+11	1-3	NONE	N/A	N/A
90	DSTAB+11	4	(a)	NO ATTITUDE ON (OFF)	N/A
90	DSTAB+11	5	NONE	N/A	N/A
90	DSTAB+11	6	(a) (d)	GIMBAL LOCK ON (OFF)	N/A
90	DSTAB+11	7	NONE	N/A	N/A
90	DSTAB+11	8	(a)	TRACKER FAIL ON (OFF)	N/A
90	DSTAB+11	9	(a)	PROGRAM ALM ON (OFF)	N/A
90	DSTAB+11	10-15	NONE	N/A	N/A
91	TIME 2 (MS)	1-15	(e) (f) CONVERT	CMC TIME XXXX HRS XX MIN	1/360,000
92	TIME 1 (LS)	1-15	TO DECIMAL	XX. XX SEC	
93	CHNL 11	1	(a)	ISS WARNING ON (OFF)	N/A
93	CHNL 11	2	(b)	COMPUTER	N/A
93	CHNL 11	3	(b)	UPLINK	N/A
93	CHNL 11	4	(a)	TEMP CAUTION ON (OFF)	N/A
93	CHNL 11	5	(a)	KEY RELEASE ON (OFF)	N/A
93	CHNL 11	6	(a) (g)	FLASH VERB-NOUN ON (OFF)	N/A
93	CHNL 11	7	(a) (h)	OPERATOR ERR ON (OFF)	N/A
93	CHNL 11	8-12	NONE	N/A	
93	CHNL 11	13	(a)	ENGINE ON ON (OFF)	N/A
93	CHNL 11	14-15	NONE	N/A	N/A
94	CHNL 12	1	(a)	ZERO OPT CDUS ON (OFF)	N/A
94	CHNL 12	2	(a)	ABL OPT ER CTR ON (OFF)	N/A
94	CHNL 12	3	NONE	N/A	N/A
94	CHNL 12	4	(a)	COARSE ALIGN ON (OFF)	N/A
94	CHNL 12	5	(a)	ZERO ICDUS ON (OFF)	N/A

TABLE 224-2 (Continued)

WORD NO.	WORD NAME	BITS	DATA MANIPULATION See Notes (-)	DISPLAY	SCALE FACTOR
94	CHNL 12	6	(a)	IMU ERR CTR ON (OFF)	N/A
94	CHNL 12	7	NONE	N/A	N/A
94	CHNL 12	8	(a)	TVC ENABLE ON (OFF)	N/A
94	CHNL 12	9	(a)	SAT TAKOVR ABL ON (OFF)	N/A
94	CHNL 12	10-12	NONE	N/A	N/A
94	CHNL 12	13	(a)	SAT INJ SEQ ST ON (OFF)	N/A
94	CHNL 12	14	(a)	SAT CUTOFF ON (OFF)	N/A
94	CHNL 12	15	(a)	ISS TRNON COMP ON (OFF)	N/A
95	CHNL 13	1-4	NONE	N/A	N/A
95	CHNL 13	5	(a)	INHIBIT UPLINK ON (OFF)	N/A
95	CHNL 13	6-7	NONE	N/A	N/A
95	CHNL 13	8	(a)	BMAG CTR ABL ON (OFF)	N/A
95	CHNL 13	9	NONE	N/A	N/A
95	CHNL 13	10	(a)	TEST ALARMS ON (OFF)	N/A
95	CHNL 13	11	(a)	ABL CMC STBY ON (OFF)	N/A
95	CHNL 13	12-15	NONE	N/A	N/A
97	CHNL 30	1	(a)	ULLAGE OFF (ON)	N/A
97	CHNL 30	2	(a)	SM SEPARATE OFF (ON)	N/A
97	CHNL 30	3	(a)	SPS READY OFF (ON)	N/A
97	CHNL 30	4	(a)	SIVB SEP/ABT OFF (ON)	N/A
97	CHNL 30	5	(a)	LIFTOFF OFF (ON)	N/A
97	CHNL 30	6	(a)	GUIDNCE REF RL OFF (ON)	N/A
97	CHNL 30	7	(a)	OPT CDU FAIL OFF (ON)	N/A
97	CHNL 30	8	NONE	N/A	N/A
97	CHNL 30	9	(a)	IMU OPERATE OFF (ON)	N/A
97	CHNL 30	10	(a)	S/C CTL SATURN OFF (ON)	N/A
97	CHNL 30	11	(a)	IMU CAGE OFF (ON)	N/A
97	CHNL 30	12	(a)	ISS CDU FAIL OFF (ON)	N/A
97	CHNL 30	13	(a)	IMU FAIL OFF (ON)	N/A
97	CHNL 30	14	(a)	ISS TRNON RQST OFF (ON)	N/A
97	CHNL 30	15	(a)	TEMP IN LIM OFF (ON)	N/A

TABLE 224-2 (Continued)

WORD NO.	WORD NAME	BIT	DATA MANIPULATION See Notes (-)	DISPLAY	SCALE FACTOR
98	CHNL 31	1	(a)	+PITCH MAN ROT OFF (ON)	N/A
98	CHNL 31	2	(a)	-PITCH MAN ROT OFF (ON)	N/A
98	CHNL 31	3	(a)	+YAW MAN ROT OFF (ON)	N/A
98	CHNL 31	4	(a)	-YAW MAN ROT OFF (ON)	N/A
98	CHNL 31	5	(a)	+ROLL MAN ROT OFF (ON)	N/A
98	CHNL 31	6	(a)	-ROLL MAN ROT OFF (ON)	N/A
98	CHNL 31	7	(a)	+X TRANS OFF (ON)	N/A
98	CHNL 31	8	(a)	-X TRANS OFF (ON)	N/A
98	CHNL 31	9	(a)	+Y TRANS OFF (ON)	N/A
98	CHNL 31	10	(a)	-Y TRANS OFF (ON)	N/A
98	CHNL 31	11	(a)	+Z TRANS OFF (ON)	N/A
98	CHNL 31	12	(a)	-Z TRANS OFF (ON)	N/A
98	CHNL 31	13-14	NONE	N/A	N/A
98	CHNL 31	15	(a)	G/N CONTROL OFF (ON)	N/A
99	CHNL 32	1	(a)	+PITCH MIN IMP OFF (ON)	N/A
99	CHNL 32	2	(a)	-PITCH MIN IMP OFF (ON)	N/A
99	CHNL 32	3	(a)	+YAW MIN IMP OFF (ON)	N/A
99	CHNL 32	4	(a)	-YAW MIN IMP OFF (ON)	N/A
99	CHNL 32	5	(a)	+ROLL MIN IMP OFF (ON)	N/A
99	CHNL 32	6	(a)	-ROLL MIN IMP OFF (OFF)	N/A
99	CHNL 32	7-10	NONE	N/A	N/A
99	CHNL 32	11	(a)	LM ATTACHED OFF (ON)	N/A
99	CHNL 32	12-15	NONE	N/A	N/A
100	CHNL 33	1-9	NONE	N/A	N/A
100	CHNL 33	10	(a)	BLOCK UPLINE OFF (ON)	N/A
100	CHNL 33	11	(a)	UPLINK TOO FAST OFF (ON)	N/A
100	CHNL 33	12	(a)	DWNLK TOO FAST OFF (ON)	N/A
100	CHNL 33	13	(a)	PIPA FAIL OFF (ON)	N/A
100	CHNL 33	14	(a)	CMC WARNING OFF (ON)	N/A
100	CHNL 33	15	(a)	OSC ALARM OFF (ON)	N/A

TABLE 224-2 (continued)

Notes:

a) If the bit indicated equals 1, display the word underlined. If the bit indicated equals 0, display the word parenthesis.

b) If the bit indicated equals 1, set the SGS discrete that displays the word in the display column. If the bit equals 0, remove the appropriate SGS discrete.

c) Display the following:

BIT 4	BIT 5	"XXX" DISPLAY
0	0	OFF
0	1	ZER
1	0	CMC
1	1	MAN

d) Store bit STATUS for G&N 631.

e) Combine the 14 magnitude bits of the most significant part (MS) with 14 magnitude bits of the least significant part (LS). The decimal conversion should be made only after the two parts of the double precision word have been sign checked. The signs appear in bit 15 of each word.

f) Store values of TIME 1, TIME 2 and RANGE TIME for G&N 602.

g) Store bit status for G&N 622 and G&N 632

h) Store bit status for G&N 631.

Title: GC Clock Initialization Program G&N 601

Part Of: Mission Initialization and GC Alignment Program

Purpose: This program sets the GC clock registers TIME 1 and TIME 2 equal to some predetermined preset value at a given Range Time.

The purposes of G&N 601 are as follows:

A. To insert into the GC clock registers a predetermined preset value of time at a given range time.

B. Insert in GC erasable memory a double precision value of Time-to-Epoch, when required.

C. Prepare inputs for G&N 602

NOTE: The uplink transmission (Noun-Verb sequence) format will be the same for the primary and secondary functions of this specification.

Calling Sequence: A. Enter Range Time (T_{RP}) for insertion of the GC clock preset value by the following C-START entry:

1) Windows 10-9 insert 90
2) Windows 8-7 insert XX hours of T_{RP}
3) Windows 6-5 insert XX minutes of T_{RP}
4) Windows 4-2 insert XXX seconds of T_{RP} (to the nearest tenth)
5) Window 1 insert 0

B. Insert the GC clock preset value as follows:

1) Windows 10-9 insert 91
2) Windows 8-5 insert ±XXX hours of E_p
3) Windows 4-3 insert XX minutes of E_p
4) Windows 2-1 insert XX seconds of E_p

C. Insert the first GC address of the time registers into which the preset value E_p is to be stored, also enter the constant K for G&N 602. This C-START entry is:

1) Windows 10-9 insert 70

2) Windows 8-4 insert YYYYY the 5 digit GC octal address for the time registers.

3) Windows 3-2 insert XXX milleseconds for K.

D. Enter the Epoch time, T_E, that is to be stored in the GC.

1) Windows 10-9 insert 80

2) Windows 8-5 insert ± XXX hours of T_E

3) Windows 4-3 insert XX minutes of T_E

4) Windows 2-1 insert XX seconds of T_E

E. Enter the GC octal address, LOC, into which T_E is to be stored.

1) Windows 10-9 insert 71

2) Windows 8-4 insert YYYYY octal address LOC.

3) Windows 3-1 insert 000

F. Call up G&N 601 through the R-START Module specified in the PRPS.

Input Data:

T_{R_1} - Range Time maintained in ACE-S/C computer.

E_p - Preset time to be inserted in GC clock.

T_{RP} - Range time at which E_p is to be inserted.

T_E - Time to Epoch when required.

Normal Exit: Uplink Transmission to the GC and temporary storage of the following quantities.

K - transmission delays to be supplied jointly by AC and G. E.

T_{HRS} - Range time truncated to hrs.

T_{R_1} - Range time

E_p - Preset time

Error Exit: None.

Computation Sequence: The following sequence should occur:

1) When Range Time, T_{GC}, is equal to T_{RP}, the quantities E_p and the address for the time registers are transmitted uplink using the commands listed under Uplink Commands.

2) If LOC is not equal to zero, then the quantities T_E and LOC are transmitted uplink using the commands listed under Uplink Commands.

3) Store the following items for inputs into G&N 602:

T_{R_1} - Range time, which is also equal to T_{RP}

E_p - Preset time

T_{HRS} - The value of T_{R_1}, truncated to hours

K - constant to be used in G&N 602

4) All uplink commands are to be time tagged and filed on the Uplink File Tape.

5) Before the double precision words E_p and T_E are transmitted uplink they must be converted to double precision words which have a least significant bit of 10 millesecond value.

		Key Code Complement	
1	XXXXX	XXXXX	XXXXX
	5 Bit Keycode		5 Bit Keycode

Figure 601-1

Command Uplink: All uplink transmissions per Figure 601-1 will be as follows·

1	10001	01110	10001	(VERB)
1	00010	11101	00010	(2)
1	00100	11011	00100	(4)
1	11111	00000	11111	(NOUN)
1	10000	01111	10000	(0)
1	00001	11110	00001	(1)
1	11100	00011	11100	(ENTER)
1	$0_1 0_1 0_1 0_1 0_1$	$\overline{0_1 0_1 0_1 0_1 0_1}$	$0_1 0_1 0_1 0_1 0_1$	(DIGIT 1, OCTAL ADDRESS)
1	$0_2 0_2 0_2 0_2 0_2$	$\overline{0_2 0_2 0_2 0_2 0_2}$	$0_2 0_2 0_2 0_2 0_2$	(DIGIT 2, OCTAL ADDRESS)
1	$0_3 0_3 0_3 0_3 0_3$	$\overline{0_3 0_3 0_3 0_3 0_3}$	$0_3 0_3 0_3 0_3 0_3$	(DIGIT 3, OCTAL ADDRESS)
1	$0_4 0_4 0_4 0_4 0_4$	$\overline{0_4 0_4 0_4 0_4 0_4}$	$0_4 0_4 0_4 0_4 0_4$	(DIGIT 4, OCTAL ADDRESS)
1	$0_5 0_5 0_5 0_5 0_5$	$\overline{0_5 0_5 0_5 0_5 0_5}$	$0_5 0_5 0_5 0_5 0_5$	(DIGIT 5, OCTAL ADDRESS)
1	11100	00011	11100	(ENTER)
1	$0_1 0_1 0_1 0_1 0_1$	$\overline{0_1 0_1 0_1 0_1 0_1}$	$0_1 0_1 0_1 0_1 0_1$	(DIGIT 1, WORD 1)
1	$0_2 0_2 0_2 0_2 0_2$	$\overline{0_2 0_2 0_2 0_2 0_2}$	$0_2 0_2 0_2 0_2 0_2$	(DIGIT 2, WORD 1)
1	$0_3 0_3 0_3 0_3 0_3$	$\overline{0_3 0_3 0_3 0_3 0_3}$	$0_3 0_3 0_3 0_3 0_3$	(DIGIT 3, WORD 1)
1	$0_4 0_4 0_4 0_4 0_4$	$\overline{0_4 0_4 0_4 0_4 0_4}$	$0_4 0_4 0_4 0_4 0_4$	(DIGIT 4, WORD 1)
1	$0_5 0_5 0_5 0_5 0_5$	$\overline{0_5 0_5 0_5 0_5 0_5}$	$0_5 0_5 0_5 0_5 0_5$	(DIGIT 5, WORD 1)
1	11100	00011	11100	(ENTER)
1	$0_1 0_1 0_1 0_1 0_1$	$\overline{0_1 0_1 0_1 0_1 0_1}$	$0_1 0_1 0_1 0_1 0_1$	(DIGIT 1, WORD 2)
1	$0_2 0_2 0_2 0_2 0_2$	$\overline{0_2 0_2 0_2 0_2 0_2}$	$0_2 0_2 0_2 0_2 0_2$	(DIGIT 2, WORD 2)
1	$0_3 0_3 0_3 0_3 0_3$	$\overline{0_3 0_3 0_3 0_3 0_3}$	$0_3 0_3 0_3 0_3 0_3$	(DIGIT 3, WORD 2)
1	$0_4 0_4 0_4 0_4 0_4$	$\overline{0_4 0_4 0_4 0_4 0_4}$	$0_4 0_4 0_4 0_4 0_4$	(DIGIT 4, WORD 2)
1	$0_5 0_5 0_5 0_5 0_5$	$\overline{0_5 0_5 0_5 0_5 0_5}$	$0_5 0_5 0_5 0_5 0_5$	(DIGIT 5, WORD 2)
1	11100	00011	11100	(ENTER)
1	11001	00110	11001	(KEYBOARD RELEASE)

Verify:	Each Uplink Transmission is to be verified via CSR Verify response. A non-verify response should be indicated by a CRT display of "TIME ERROR 1".
Store:	T_{R_1}, E_p, T_{HRS}, and K for inputs to G&N 602
CRT Display:	"TIME EPOCH XXX HRS XX MINS XX.XXX SECS"
Operator Action:	Console Operator: When Clock Initialization Program is desired, perform the C-START entries before R-START call-up of G&N 601 is made. Make sure there is no other major Uplink Activity at this time. Spacecraft Operator: No activity required.
Uplink Requirements:	See COMPUTATION SEQUENCE.
Downlink Requirements:	Measurement ID: Not applicable. Tolerance: Not applicable.
Remarks:	Definition of terms used in this subprogram are as follows: T_{R_1} - Range Time (hrs, mins, secs, ms) E_p - Preset time for GC clock (hrs, mins, secs, ms) T_{RP} - Range time at which E_p is to be inserted (hrs, mins, secs, ms). T_E - Time to Epoch (hrs, mins, secs, ms) K - Transmission delays (ms) LOC - Location (octal) of address in erasable GC memory. T_{HRS} - Range time truncated to Hrs.

Title: GC Time Verification Program G&N 602

Part Of: Mission Initialization and GC Alignment Program

Purpose: This program is designed to align the GC time clock to the Range Time reference. This program calculates the time alignment Δt which is to be added algebraically to the GC clock register TIME1 and TIME2 to correct for transmission delays in loading and reading these registers.

Calling Sequence: Call-up through the R-START Module specified in the PRPS or PRD.

Inputs:

T_{R_1} = from G&N 601 - Range time of initiation (hrs, mins, secs, ms)

T_{HRS} = Range time truncated to Hrs from G&N 601

K = Transmission delays from G&N 601

E_P = Preset time inserted in GC Clock from G&N 601

T_A = Time from G&N 624 or 224

T_{R_2} = Range Time of GC time receipt

Normal Exit: Display Δt in seconds.

Error Exit: Display error sources as specified.

Computation Sequence:

Compute $\Delta t = (T_{R_2} - T_{R_1}) - (T_A - E_P) - K$

Note: See explanatory flow chart of Δt calculation (Figure 602-1) and explanation of computations in "Remarks" section.

Display: Δt (in seconds, decimal) in the following format:

"DELTA TIME ± XXX.XXX SECS"

Store: Δt as input to G&N 603

Test:

(1) If $|\Delta t| \geq 15$ minutes display "TIME ERROR 2".
If $|\Delta t| < 15$ minutes, continue.

(2) When T_A is sampled for G&N 602 sampling should not occur while the GC time registers in the Downlink Computer memory are being updated.

Since the Range Time is initialized every 24 hours, it is necessary to program a counter which contains the total hours from the initiation of G&N 601. A proposed flow chart for such a routine is given in Figure 602-1.

It should be noted that T_{R_2}, T_{R_1} and T_A can be broken down into units of hours, minutes, seconds and milliseconds. The compare statements in Figure 602-1 use only units of hours which are truncated.

Operator Action:

Console Operator: When time verification program is desired, call up is made through R-START Module activation.

Spacecraft Operator: No activity required.

Uplink Requirements:

Transmission to GC: None

DTCS Stimuli Location: Not Applicable

Time of Transmission: Not Applicable

Downlink Requirements:

Measurement ID: Measurement No. G 0001V

Tolerance:

If program fails Δt test, indicate failure by display indicated under TEST in "Computations" section and return to Uplink Control Program.

Failure of program to execute because of no GC time available should be indicated by "TIME ERROR 4" and exit should be made to Uplink Control Program.

The accuracy of Δt is to be 10 milliseconds.

Filing Requirements:

During System Tests a recording of T_{R_1}, T_{R_2}, E_P, T_A, K, $T_{R_{HRS}}$, $T_{R_{2(HRS)}}$ and DCNT should be made.

Remarks:

Definition of terms used in this subprogram are as follows:

T_{R_1} - Range time from G&N 601 in hrs, mins, secs, ms.

T_{HRS} - Range time from G&N 601 truncated to hrs.

K = Transmission delays from G&N 601 in ms.

E_P = Present Time insert in LGC clock from G&N 601, in hrs, mins, secs, ms.

T_A - GC time from G&N 224 or G&N 624 in hrs, mins, secs, ms.

T_{R_2} - Range time of GC time receipt in hrs, mins, secs, ms.

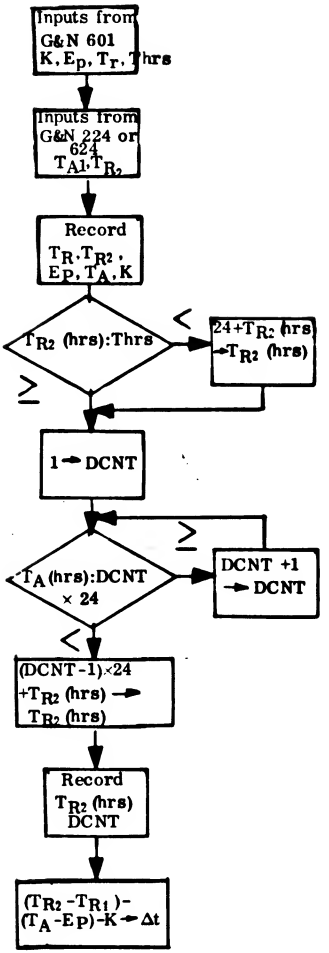

Inputs from G&N 601 K, E_p, T_r, Thrs
Inputs from G&N 224 or 624 T_{A1}, T_{R_2}
Record T_R, T_{R^2}, E_p, T_A, K
T_{R_2} (hrs):Thrs
<
24+T_{R_2} (hrs) → T_{R^2} (hrs)
≥
1 → DCNT
T_A (hrs):DCNT × 24
≥
DCNT +1 → DCNT
<
(DCNT-1)×24 +T_{R_2} (hrs) → T_{R_2} (hrs)
Record T_{R_2} (hrs) DCNT
(T_{R_2} - T_{R_1}) - (T_A - E_p) - K → Δt

Figure 602-1

Title: GC Time Correction G&N 603

Part Of: Mission Initialization and GC Clock Alignment Program

Purpose: This program adds, algebraically, the differential time correction, Δt, to the GC clock to align it to Range Time. This program formats and transmits through the GC Uplink the Δt which is then added to the GC to complete the alignment. G&N 601 and 602 must have been successfully executed before G&N 603 is executed.

Calling Sequence: Entry: Call-up through the R-START Module specified in the PRPS or PRD.

Input: Δt from G&N 602

Normal Exit: Display Δt as per G&N 602. Return to Uplink Control Program.

Error Exit: Display "TIME ERROR 3" to indicate Δt not transmitted or incorrectly transmitted.

Computations Sequence:

1) Transmit Δt by the following Uplink Transmission. The format of the GC Uplink Transmission is given in Figure 603-1.

	Keycode Complement		
XXXXX	$\overline{\text{XXXXX}}$	XXXXX	
5 Bit Keycode		5 Bit Keycode	

Figure 603-1. LGC UPLINK FORMAT

1	10001	01110	10001	(VERB)
1	00101	11010	00101	(5)
1	00101	11010	00101	(5)
1	11100	00011	11100	(ENTER)
1	SIGN	$\overline{\text{SIGN}}$	SIGN	(SIGN OF Δt)
1	$0_1 0_1 0_1 0_1 0_1$	$\overline{0_1 0_1 0_1 0_1 0_1}$	$0_1 0_1 0_1 0_1 0_1$	(1st DIGIT OF Δt)
1	$0_2 0_2 0_2 0_2 0_2$	$\overline{0_2 0_2 0_2 0_2 0_2}$	$0_2 0_2 0_2 0_2 0_2$	(2nd DIGIT OF Δt)
1	$0_3 0_3 0_3 0_3 0_3$	$\overline{0_3 0_3 0_3 0_3 0_3}$	$0_3 0_3 0_3 0_3 0_3$	(3rd DIGIT OF Δt)
1	$0_4 0_4 0_4 0_4 0_4$	$\overline{0_4 0_4 0_4 0_4 0_4}$	$0_4 0_4 0_4 0_4 0_4$	(4th DIGIT OF Δt)
1	$0_5 0_5 0_5 0_5 0_5$	$\overline{0_5 0_5 0_5 0_5 0_5}$	$0_5 0_5 0_5 0_5 0_5$	(5th DIGIT OF Δt)
1	11100	00011	11100	(ENTER)
1	11001	00110	11001	(KEYBOARD RELEASE)

Verify: Each Uplink Word Transmission by using appropriate Uplink Verification Program. Indicate transmission failure by CRT display "TIME ERROR 3".

Operator Action:

Console Operator: When G&N 603 is desired, call-up is made through R-START Module activation.

Spacecraft Operator: No activity required.

Uplink Requirements:

See "Computations" Sequence.

DTCS Stimuli Location: not applicable

Time of Transmission: no requirement

Filing Requirements: All information transmitted should be recorded on Uplink Command File Tape.

Downlink Requirements:

Measurement ID: not applicable.

CRT Display: See Exits under Calling Sequence.

Processing Category: See Program No. G&N 602

Remarks: This mode requires previous calculation of Δt by G&N 602. The sign and five most significant digits are transmitted uplink.

Title: Guidance Computer Downlink Format Program G&N 621

Part Of: Downlink Program

Purpose: The LGC transmits blocks of five 8-bit words (time slots 65-69) into the PCM T/M at a 50 block per second rate. These data blocks represent a complete cycle through one LGC Downlist. The Downlist consists of a fixed length of 100 LGC words, each data block representing 2 of these words. Several lists are specified for LEM Block II, where the list address contained in the ID word identifies the transmitted parameters.

The Downlink Format subprogram accepts each block of five 8-bit words, verifies parity, and reformats each word into a 16-bit format. The type of LGC word represented is identified and the word is routed to other ACE-S/C subprograms for subsequent processing.

Calling Sequence: Entry: This subprogram operates under Downlink Executive Program control and is initiated by receipt of an Executive program interrupt.

Data: 1) A sequence of 50 blocks of five 8-bit words during 1 second.

2) Notification upon loss of a block (prime frame) or sequence of 50 blocks (sub-frame).

Normal Exit: Valid data is transmitted to the appropriate ACE-S/C subprogram for further processing and display.

Error Exit: Error conditions will be displayed on the CRT and recorded on the Downlink file tape. A search for an ID word to enable further data processing, occurs under certain error conditions. The CRT error displays are detailed in Table 621-2.

Computation Sequence:

The program receives blocks of five 8-bit words, configured as follows:

WORD 1	WOC	S/15	14	13	12	11	10	9
WORD 2	8	7	6	5	4	3	2	1
WORD 3	P	S/15	14	13	12	11	10	9
WORD 4	8	7	6	5	4	3	2	1
WORD 5	P	X	X	X	X	X	X	X

where WOC = Word order code (1 bit)
P = Odd parity (LGC word)
X = 0 as presently configured

The data block contains 2 LGC 16-bit data or DSPTAB words, except where an ID word is encountered. The individual word formats are specified below. The LGC data word includes a parity (P) and sign (S) bit. (See Figure 621-1.

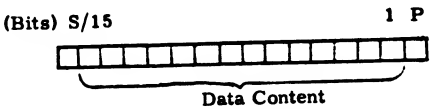
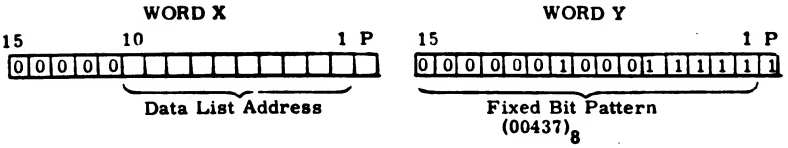


Figure 621-1

The DSPTAB word format is essentially as specified in Figure 621-1, as far as this program is concerned.

The identification (ID) word format contains five leading zeros with bits 1-10 containing the data list address. The complete ID word format is:



Word X precedes Word Y in the data block transmittal (Word 1 - Word 5). The Word order code (WOC) bit contains a 1 for all data and DSPTAB words, and a 0 for the ID word. The position of the LGC word in the fixed length list determines whether the word is to be processed for data monitoring or for DSKY display monitoring. Table 621-1 contains the specified Downlink lists which initiate the operation of this program.

Basically, Program G&N 621 receives PCM data blocks, checks parity, and determines the word type, to allow the transfer of 16-bit words to ACE-S/C programs for subsequent processing. A word count is utilized to detect any deviation from the normal list transmission. A block count is also utilized to indicate if both words in the data block have been processed and so allow the reading in of another block.

When an error is sensed, display and recording of pertinent information takes place and depending upon the type of error, control is transferred to point C in the flow chart (Figure 621-2) where a search for an ID word is initiated.

If a DSPTAB word is detected, then bit 15 is checked for a '1' indication. If a '1' is encountered the word must be complemented prior to transmitting the word to G&N 622 for further processing. Upon detection of an ID word, the data list address is transmitted to G&N 624 to allow that program to utilize the correct display format and scaling information. Figure 621-2 is given as a representative flow, to convey the intent of the subprogram operation.

Operator Action:

Console Operator: No activity required.

Spacecraft Operator: No activity required.

Uplink Requirements:

Not applicable

Downlink Requirements:

Filing: Upon detection of an error the appropriate information is recorded on the Downlink file tape as specified in the flow chart and Table 621-2. (Applicable until the Downlink File capability is removed.)

Display: This information is detailed in the flow chart and consists of program error displays as specified in Table 621-2. The ACE requirements specification contains the CRT page and line information.

Table 621-1

BASIC DOWNLIST FORMAT FOR LEM BLOCK II

WORDCNT	DATA	Five-Word BLOCK	WORDCNT	DATA	Five-Word BLOCK
1 and 2	ID	1	87 88	DSPTAB +8 DSPTAB +9	44
3 - 76	37 DP words, the data contents of which are specified by the ID list address	2 - 38	89 90	DSPTAB +10 DSPTAB +11	45
77 78	UPLOCK T6LOC	39	91 92	TIME 2 TIME 1	46
79 80	DSPTAB +0 DSPTAB +1	40	93 94	(Channel 11) (Channel 12)	47
81 82	DSPTAB +2 DSPTAB +3	41	95 96	(Channel 13) (Channel 14)	48
83 84	DSPTAB +4 DSPTAB +5	42	97 98	(Channel 30) (Channel 31)	49
85 86	DSPTAB +6 DSPTAB +7	43	99 100	(Channel 32) (Channel 33)	50

Four ID groups shall be accepted as valid by this program:

Downlist No.	Word 1_8	Word 2_8
1	00321	00437
2	01610	00437
3	01437	00437
4	00001	00437

Table 621-2 (Continued)

Error Description	CRT Display	File Tape Listing
This indicates that Wordcnt has incremented beyond a specified limit, with no ID word detected.	SYNCERR 1	621, SYNCERR1, Time Tag Reference, WORDCOUNT, 5 word block
At this point Wordcnt should be 101, if an ID has been received in the correct sequence.	SYNCERR 2	621, SYNCERR 2, Time Tag reference, WORDCOUNT, 5-word block.
Parity is incorrect in the first LGC word in data block.	WORDERR 1	621, WORDERR1, Time Tag reference, 5 word block, WORDCOUNT.
Parity is incorrect in the second LGC word in data block.	WORDERR 2	621, WORDERR 2, Time Tag reference, 5 word block, WORDCOUNT.
ID word (bits 11 - 15) $\neq (00)_8$	WORDERR 3	621, WORDERR 3, Time Tag reference, 5 word block, WORDCOUNT.
Fixed bit pattern in ID word is illegal.	WORDERR 4	621, WORDERR 4, Time Tag reference, 5 word block, WORDCOUNT.
Invalid list address encountered after attempting to utilize second LGC word to identify ID word.	WORDERR 5	621, WORDERR 5, Time Tag reference, 5 word block, WORDCOUNT
Invalid list address encountered in the first LGC word in data block.	WORDERR 6	621, WORDERR 6, Time Tag reference, 5 word block, WORDCOUNT.
Parity is incorrect in ID word.	WORDERR 7	WORDCOUNT, 5 word block WORDERR 7, Time tag ref.

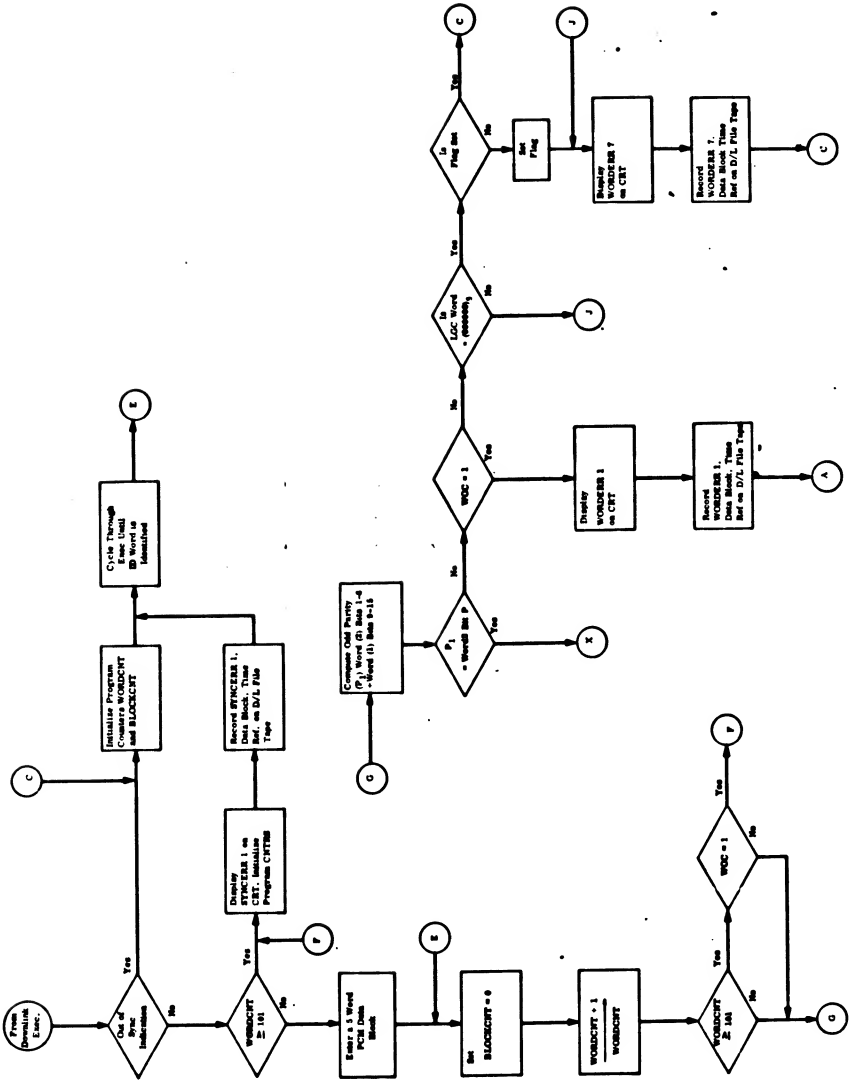


Figure 621-2 (1 of 3)

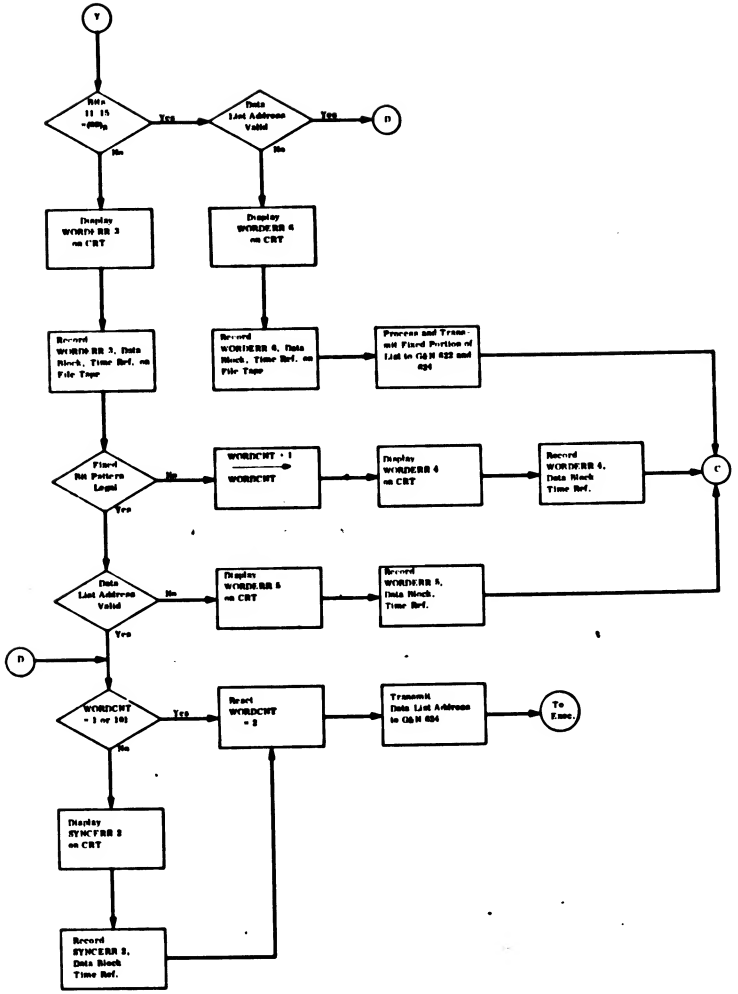


Figure 621-2 (2 of 3)

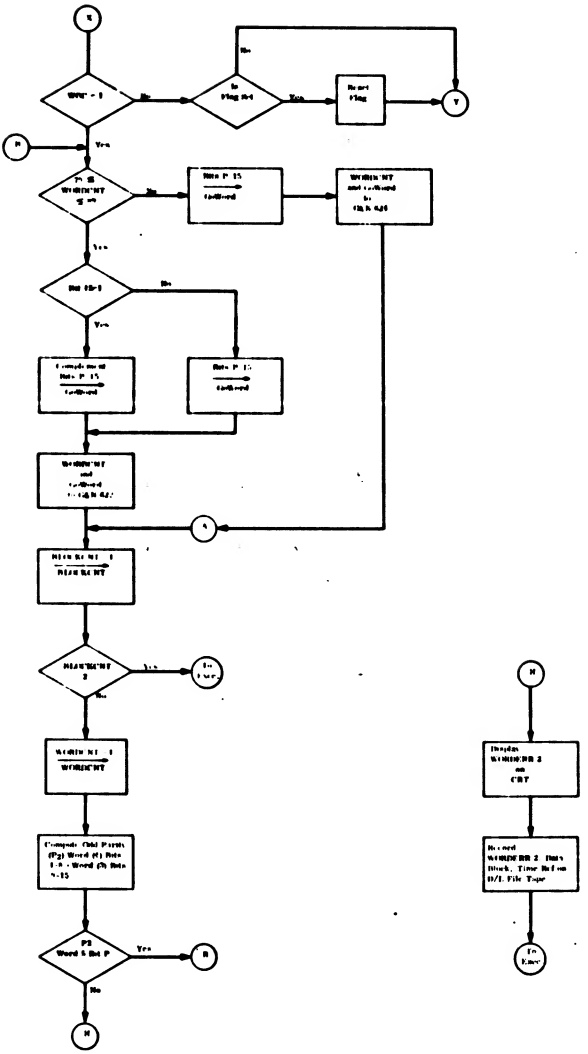


Figure 621-2 (3 of 3)

Title: GC Display Program G&N 622

Part Of: Downlink Program

Purpose: The GC Display Program interprets all GC Display words that are detected as such by the GC Downlink Format Program G&N X21 and generates CRT displays identical in content and format to the on-board spacecraft displays. This program provides ACE-S/C ground station test personnel the capability of continuously monitoring all spacecraft keyboard displays.

Calling Sequence: Entry: This program is activated only by the GC Downlink Format Program whenever it is processing Downlink data.

Data: Input: Inputs to the display program consist of a complete 16 bit AGC Downlink Display word.

Output: Outputs consist of coded CRT display information which will be available for input to the Symbol Generator System (SGS) memory.

Normal Exit: Normal exit will be a return to the ACE Executive Program so it can provide data for program G&N X21.

Error Exit: Error conditions will cause error information to be displayed on the CRT and recorded on the downlink file tape. After error recording, control is returned to the ACE Executive Program. Error messages are detailed in Table 622-3.

Computation Sequence: Activation of the GC Display Program is attained via the GC Downlink Format Program, G&N X21. Inputs to this program will be two 8-bit words and a word count value from 79 to 89 inclusive. The word count specifies the position of the display word in the Downlink list which in turn is used to identify the specific format of the display word.

The two 8-bit words constitute a full 16-bit AGC Downlink Display word. The format of this word is shown in Figure 622-1.

Display Words (Figure 622-1) consist of four parts of coded information:

1. The address in bits 15-12 is not used in Block II.

Since the display words from the DSPTAB table are sequentially transmitted Downlink, the Downlink Format Program (G&N X21) will supply this subprogram a word count which will properly identify each display word as defined in Table 622-1.

2. The special code in bit 11 specifies a particular discrete associated with the Display word.

3. Bits 10-6 and 5-1 represent Display Codes which are associated with specific Display Names. These codes specify the numeric character to be displayed according to Table 622-2.

Example: A Display Word with a bit configuration as shown in Figure 622-2 and a word count of 83 should cause the ACE Display Program to:

1. Select the Display Word corresponding to associated word count 83 according to Table 622-1.

2. Set the sign of display register (R2) to plus, according to Table 622-1.

3. Set digit 1 of display register (R2D1) to 3 according to Table 622-2.

4. Set digit 2 of display register (R2D2) to 6 according to Table 622-2.

The Display Program is activated by G&N X21 whenever display words are to be interpreted. Upon entry from G&N X21 the display program switches on the word count value to determine which of the 11 display words is to be interpreted and displayed.

Below is a brief description of the action to be taken on these display words. (See Figure 622-3 for flow diagram.)

WORD COUNT from 21	DISPLAY WORD ACTION
81, 87, 88 or 89	The special code bit (bitt 11), of these 3 display words, is meaningless, therefore control is transferred to program region 1.
86	Go to program region 2.
80, 83 or 85	Bit 11 of these display words is interpreted as follows:
bit 11 = 1	Set sign indicator of R to plus.
bit 11 = 0	Do not change the sign indicator of R.

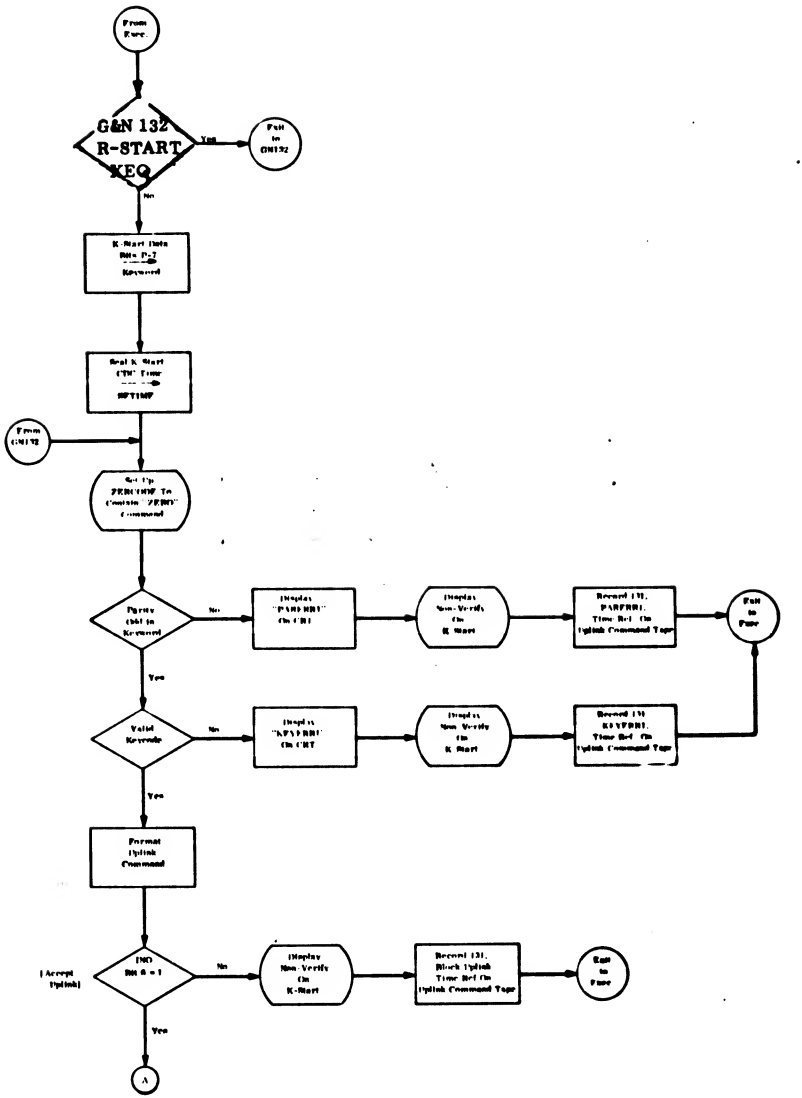


Figure 131-1 (1 of 3)

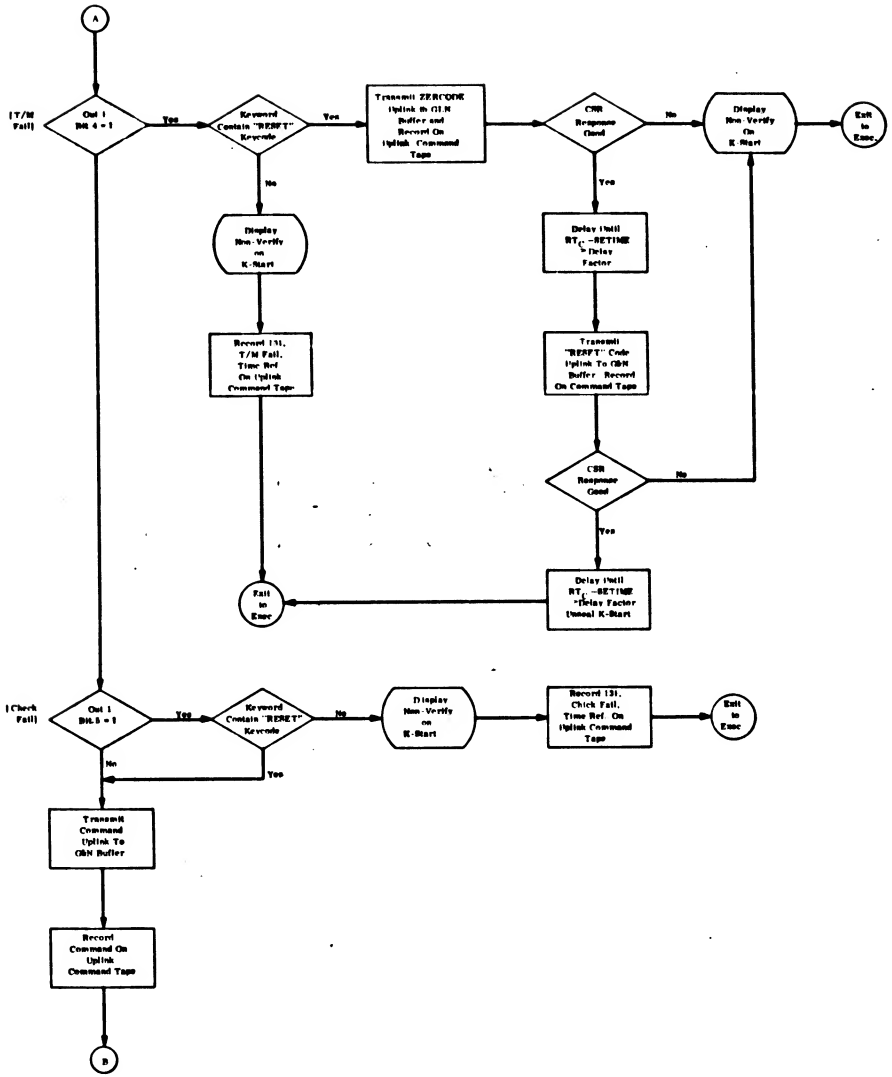


Figure 131-1 (2 of 3)

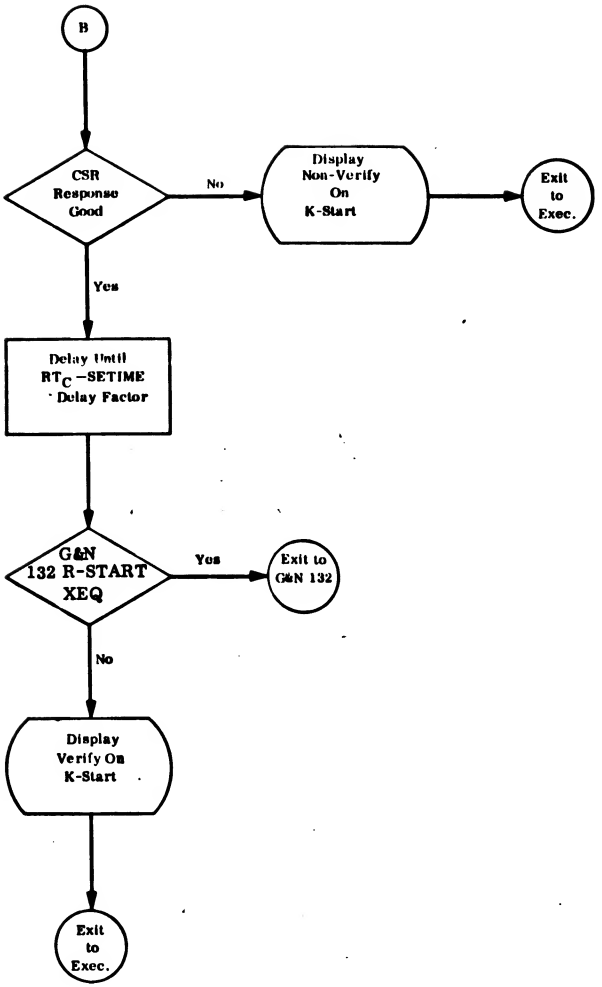


Figure 131-1 (3 of 3)

Title: Special K-Start Load-Verify, Verify, and Dump Program G&N 132

Part of: Uplink Program

Purpose: This program is used to check and verify or record the contents of AGC erasable memory locations. All data to be verified or recorded is specified on pre-punched K-Start input tapes. The format of these tapes is defined in Tables 132-1 and 132-2.

Three options have been provided for verification or recording. Selection of these options is attained through activation of R-Start Module function switches and K-Start Module specified in the PRPS.

Calling Sequence:

Entry: This program is activated only by the K-Start Module Program (G&N 131), whenever it in turn has been activated by K-Start Module and also if a particular R-Start Module has been executed. Function switches this R-Start Module specify one of three options used by G&N 132. These are:

1. Load-Verify - Verify that the data being loaded into erasable AGC memory locations is identical to the data stored on the K-Start input tape.

2. Verify - Check and verify that the contents of previously loaded and verified AGC erasable memory locations have not been altered by internal AGC functions or external input means.

3. Dump - Record on the file tape the contents of erasable memory locations specified on the pre-punched K-Start Dump input tape.

Data: This consists of information received from punched K-Start tapes. The data content utilized by this subprogram consists of five bit keycodes plus a parity level.

Normal Exit:

1. Return to G&N 131 whenever keycodes are to be checked for validity and parity and then transmitted to the AGC.
2. Return to Uplink Executive Program when a complete Special K-Start tape sequence has been processed by G&N 132 and 131.

Error Exit:

Error conditions will be displayed on the CRT for operator action and will also be recorded on the File Tape. After recording, control will be returned to the Uplink Executive Program.

Computation Sequence:

Activation of this program is attained via the K-Start Module Program, G&N 131, following operator action on an R-Start Module and K-Start Module. Execution of the R-Start must occur before K-Start action. The K-Start execute causes the ACE Executive to activate G&N 131, which in turn activates and maintains close interface with G&N 132 provided R-Start Module execution is sensed by G&N 131. If G&N 131 does not detect execution of this R-Start it then treats the K-Start input tape in a normal fashion. The paragraphs below represent a description of the logic contained in the flow diagram shown in Figure 132-1.

Program Description:

Upon entry from G&N 131 various counters and indicators are set to specific values depending on which function switch of the R-Start Module has been executed. G&N 132 then reads R1 keycode characters into the CDC and seals the K-Start Module. These keycode characters represent the initial VERB-NOUN sequence to be transmitted Uplink.

The format of this "record" is checked for validity. This should be either 18 keycode characters for the Load-Verify, Verify tape or 12 keycode characters for the Dump tape Format non-verification results in a CRT error display,

file tape recording, K-Start Module release and program control return to ACE Executive. If the Verify option has been selected, the one component load Verb-Noun is changed to one component display Verb-Noun (V21N01 to V01N01).

At this point in the program a loop is set up, based on the value of K1, which loads one keycode at a time into KEYWORD and allows G&N 131 to perform its normal function of completely verifying each keycode from G&N 132 and transmitting each Uplink. (See G&N 131). After all appropriate keycodes have been transmitted Uplink, the Flash discrete is obtained from the G&N 122 buffer. A test is made on the Flash discrete. If "1" (flashing) G&N 132 delays until the next DSPTAB table is displayed by G&N 122 and repeats the "Flash" test. A third failure in this area should cause an error exit with a CRT error display, file tape recording of pertinent data and a return to ACE Executive.

If the "Flash" discrete is "0" (stop flashing) the program delays two seconds and obtains the R1, R3, VERB and NOUN values. This delay is to assure G&N 132 that all pertinent AGC DSPTAB updated data has been received by the Display Program. Following this delay the Verb-Noun combination for the particular tape option in progress is checked for validity, the input address is compared against the contents of R3, and if the tape option in not "DUMP" the input constant is compared against the contents of R1. Any invalid test results in an error exit as specified above.

Following valid testing, G&N 132 releases the K-Start seal. reads one keycode character and checks this code for Key-release. Detection of the Key-release code will result in K-Start module seal and an exit to G&N 131 for Uplink transmission of the Key-release Keycode. When re-entered from G&N 131, the K-Start module is un-sealed, KSEQ "ok" is displayed on the CRT and G&N 132 returns control to the ACE executive. If, however, the first code of the "record" is not Key-release. G&N 132 reads R2-1 keycode characters into the CDC and seals the K-Start Module. These keycode characters represent interim "records" of keycode data necessary for the proper operation of the one parameter Load or Display Verb-Noun combination in the AGC. The format of each "record" is tested for validity. An improper format results in an error exit as previously specified. With a legal "record" the program sets up a loop, based on the K2 value, for Uplink Keycode transmission via G&N 131.

Following successful Keycode transmission G&N 132 obtains pertinent data from the G&N 122 buffer and repeats a sequence of testing as specified above with one additional test. If the "DUMP" option is in progress the R1, R3, VERB, NOUN values, Dump time, and program ID are recorded on the Downlink file tape.

Operator Action:

Console Operator:

To activate G&N 132, the R-Start Module specified in the PRPS must be executed. Three options are available:

1. Select the Load-Verify option.
2. Select the Verify option.
3. Select the Dump option.

In addition to the R-Start execute, the K-Start Module must also be activated.

The operator's responsibility also includes the monitoring of displays and the initiation of procedures based upon the display interpretation. Before initiating action to process a Special K-Start tape via G&N 132 the console operator should check and perform the following operations:

1. Depress the NON-VERIFY switch if the non-verify light is on.
2. Check the CRT status of:
 a. Accept Uplink discrete for "OFF"
 b. TM/Fail discrete for "ON"
 c. Check Fail discrete for "ON"

If any of these conditions exist, Uplink transmission will be inhibited by G&N 131. Recovery procedures for these conditions are specified in the "K-START Module Program G&N 131.

After verifying that the above conditions have been fulfilled the operator may initiate processing of the Special K-START tape as prescribed. CRT monitoring should continue during G&N 132 K-START tape processing. Illumination of the NON-VERIFY light will result in the discontinuation of the Special K-START tape processing. When this occurs the console operator should record the indicated error in order to initiate corrective procedures. The error displayed will be one of the following:

1. VERROR 1 through VERROR 5 indicates error detection in G&N 132. (See Table 132-3 definitions).

2. PARERR 1, KEYERR 1, Accept Uplink "OFF",TM/Fail "ON" or Check Fail "ON" indicate error detection in G&N 131. (See G&N 131 for definitions).

An error free K-START tape sequence will result in the CRT display of KSEQ 'OK'.

VERROR Recovery Procedures - One of three operator actions must be taken if G&N 132 detects an error (VERROR type).

1. Re-cycle - This allows a re-run of the present K-START Tape Sequence.
 a. Re-load K-START tape to VERB character.
 b. Re-initiate K-START action

2. Continue - This allows tape operation to continue from point of error.
 a. Re-initiate K-START action.

3. Abort - This terminates processing of the present K-START tape sequence.
 a. Manually insert "ERROR-RESET" Keycode to allow G&N 132 to 'unseal' the R-START module.

Spacecraft Operator:

No activity required.

Uplink Requirements:

DTCS Transmission: The word transmitted Uplink is identified in the Computation Sequence section of G&N 131.

DTCS Stimuli: None

Transmission Time: As required

Filing: All K-START command information will be recorded on the command tape by G&N 131.

Downlink Requirements:

CRT Display: This information is detailed in the program flow chart and consists of KSEQ 'OK' if no errors occur or program error displays if any are detected by either G&N 132 or G&N 131. If the test is aborted by means of the "ERROR RESET" code KSEQ 'NG' will appear on the CRT. Error displays are defined in Table 132-3. The ACE Requirements Specification contains the CRT scope page and line information.

Filing: The File Tape recordings are detailed in the program flow chart (Figure 132-1) and Table 132-3.

Remarks:

Definition of terms used in this subprogram are as follows:

1. Flag - Program indicator specifying one of three program options.

2. K1 - Counter which specifies the number of keycodes to be initially transmitted to the AGC.

3. K2 - Counter which specifies the number of keycodes to be transmitted to the AGC after initial transmission.

4. R1 - Counter which specifies the number of keycode characters to be initially read and processed.

5. R2 - Counter which specifies the number of keycode characters to be read and processed after the initial "record".

6. KEYWORD - Register containing 8-bit keycode for G&N 131 processing.

7. VERROR - Indicator set by G&N 132 whenever errors are encountered. (See Appendix IV).

8. KSEQ - CRT indicator set to display 'OK' if a complete Verb-Noun sequence is verified error free. Set to 'NG' if test is aborted due to error detection. Entry to G&N 132 blanks OK or NG.

9. BLKCNT - Value, if any, specifies K-START data block being processed when an error is detected by G&N 132.

10. WDCNT - Value, if any, specifies last tape input character which was detected as an error by G&N 132. This Word Count is used in conjunction with the Block Count error.

Bibliography: This program relies on G&N 131 for uplink transmission of keycodes.

TAPE FORMATS

Load-Verify and Verify Tape

HEADER	
Verb 21 Noun 01	ENTER
4 octal digit address	ENTER
5 octal digit constant	ENTER
	ENTER
4 octal digit address	ENTER
5 octal digit constant	ENTER
⋮	
	ENTER
4 octal digit address	ENTER
5 octal digit constant	ENTER
STOP KEYRELEASE	

Table 132-1

DUMP TAPE

HEADER	
Verb 01 Noun 01	ENTER
4 octal digit address	ENTER
	ENTER
4 octal digit address	ENTER
⋮	
	ENTER
4 octal digit address	ENTER
STOP KEYRELEASE	

Table 132-2

Table 132-3

CRT ERROR DISPLAY DEFINITION

Error	CRT Display	K-Start Module Display	File Tape Recording
Improperly formatted K-Start tape.	VERROR 1	Non-Verify	VERROR 1, Time Tag, Data "record", BLKCNT, WDCNT.
Flash discrete 'ON'. Load or display Verb-Noun address and/or data values not accepted by AGC.	VERROR 2	Non-Verify	VERROR 2, Time Tag, R1, R3, VERB NOUN, Flash discrete, and Data Record, BLKCNT, WDCNT.
DSPTAB Verb-Noun not same as input Verb-Noun.	VERROR 3	Non-Verify	VERROR 3, Time Tag, R1, R3, VERB Noun, and Data Record, BLKCNT, WDCNT.
DSPTAB address (R3) does not verify with input address.	VERROR 4	Non-Verify	VERROR 4, Time Tag, R1, R3, VERB, NOUN, and Data Record, BLKCNT, WDCNT.
DSPTAB constant (R1) does not verify with input constant.	VERROR 5	Non-Verify	VERROR 5, Time Tag, R1, R3, VERB, NOUN, and Data Record, BLKCNT, WDCNT.

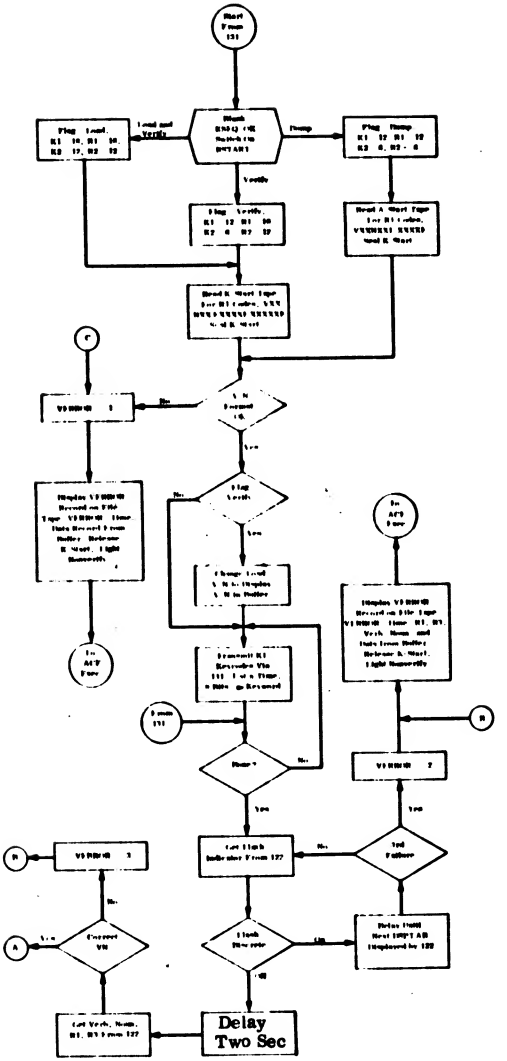


Figure 132-1 (1 of 2)

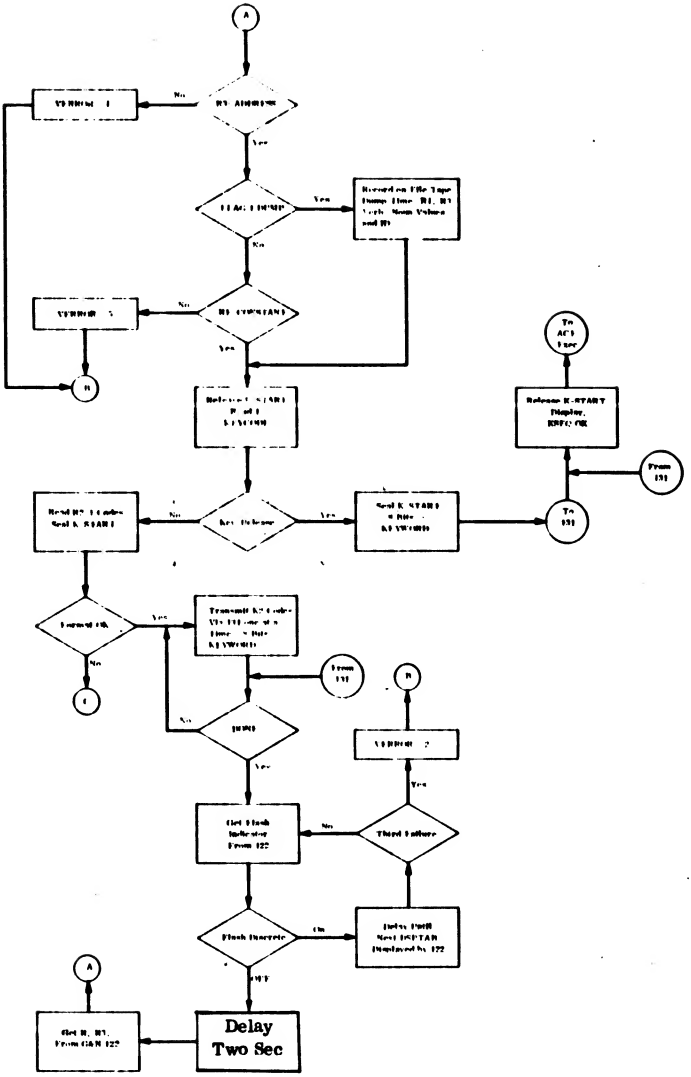


Figure 132-1 (2 of 2)

Title: G&N High Rate Channel Control Program G&N 141

Part Of: Communication Program

Purpose: This program controls the switching of selected signals for transmission over the 400 sample/second high rate sampling channel.

Calling Sequence: Entry: This program will operate under Executive Control and will be initiated from the C-START module specified in the PRPS.

Data: C-START Module data entry - Window ten (10), eight (8) and seven (7) are set to desired characters.

Normal Exit: Return to Executive Control

Error Exit: None required

Computation Sequence:

This program is entered from the Executive Program when requested by the C-START module. Selector switches eight (8) and seven (7), are utilized for high rate channel selection, while selector switch ten (10) (leftmost selector switch) will be utilized for program identification. Selector switch ten (10) will be tested, and when found to contain the digit two (2), will cause entry into the high rate channel select program. Selector switches eight (8) and seven (7) will be tested to determine which measurement, if any, is being requested. If the code contained in windows eight (8) and seven (7) exceeds the limits of the matrix (i. e. greater than 32 decimal) the program exits to Executive Control. If the code is a valid code, the program tests to determine if the code is the same as the code for the measurement presently displayed. In the event that the selection has not changed, the signal selection command is ignored and control is returned

to the Executive Program. If the code contained in windows eight (8) and seven (7) is a code for a new measurement, the program will then cause the computer to generate the commands necessary to remove the previously selected signal from the matrix and by energizing one or more of the ten high rate control relays in the DTCS, cause the new signal to be switched onto the 400 S/S channel. The relay assignments will be specified in the PRPS. Figure 141-1 is a representative flow diagram of this subprogram.

Operator Action: Console Operator action is required to initiate this program by C-START selection of the high rate signals. The sequence is as follows:

a. The desired program identification digit (2) is entered into selector switch ten (10).

b. The desired measurement identification digits are entered into selector switches eight (8) and seven (7).

c. The XEQ/SEAL Switch is depressed.

Spacecraft Operator: No activity required

Uplink Requirements:

AGC Transmission: None

Time of Transmission: Not defined

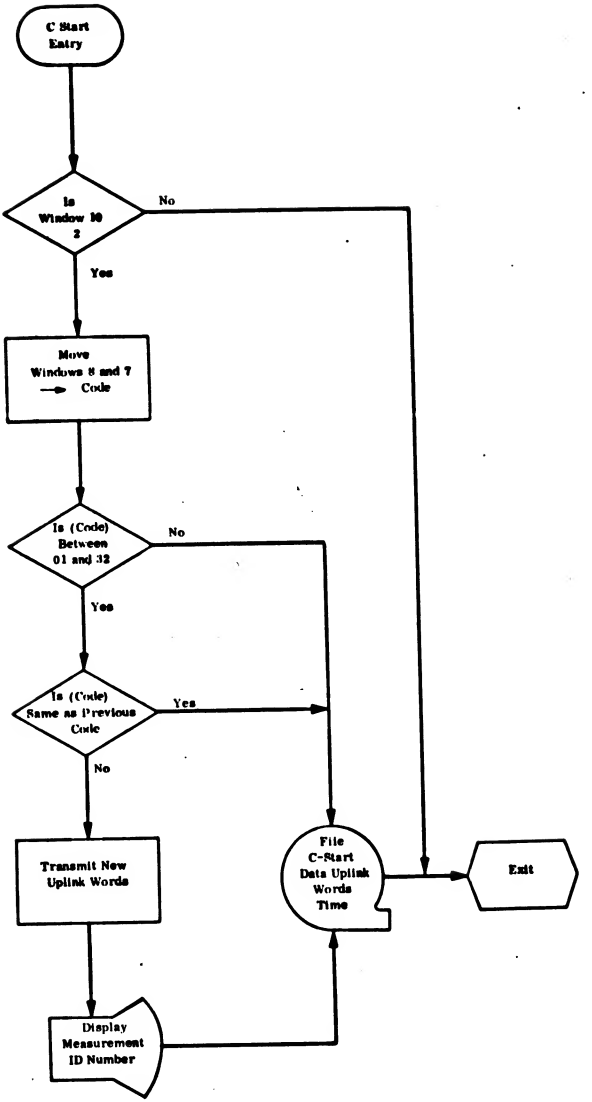
Filing Requirements: Measurement ID, time tag

Downlink Requirements:

CRT Display: The following CRT display is required "High Rate Meas. CG X X X X", where CG X X X X refers to the NASA measurement number of the particular measurement selected.

Filing Requirements: None

Remarks: The required high rate channel information should be obtained from the Program Requirements Process Specifications for the vehicle to be tested.



4-141.4

Figure 141-1

Title: Special IMU Processing, Block I Mod I G&N 152

Part Of: Communication Program

Purpose: This program converts the IMU 1X gimbal resolver sin and cos PCM values to degrees for display on the CRT.

Calling Sequence: Entry: Entry into this program will be under control of the downlink control program.

Data:

Inputs: The input data for this program consists of a) one set of calibration points for each of the six measurements; b) six PCM values at the rate of once per second representing the following measurements:

G 2112	IGA	1X	RES	SIN
G 2113	IGA	1X	RES	COS
G 2142	MGA	1X	RES	SIN
G 2143	MGA	1X	RES	COS
G 2172	OGA	1X	RES	SIN
G 2173	OGA	1X	RES	COS

Outputs: The output will consist of the three gimbal angles in degrees which are to be displayed on the CRT.

Normal Exit: Control is transferred back to the downlink control routine at the end of this program.

Computation Sequence:

The calibration data for each of the six measurements will consist of six points which will be the PCM counts corresponding to 0^{o}, 9^{o}, 18^{o}, 27^{o}, 36^{o}, and 45^{o} for each sin resolver or 90^{o}, 81^{o}, 72^{o}, 63^{o}, 54^{o} and 45^{o} for each cos resolver.

Typical outputs from the sin and cos resolvers for one revolution are shown in the figures below.

Figures 152-1 and 152-2 show the ideal case when saturation, or peak voltages E_{ps} and E_{pc}, occurs at $\theta = \pi/4$. The present signal conditioners will have a saturation point at about 74° for the sine resolvers and about 16° for the cosine resolvers. Hence, the calibration data for 45° for each measurement will be less than 254 PCM counts.

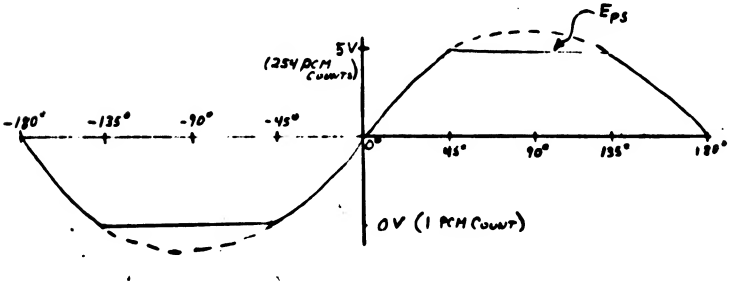


FIGURE 152-1. SIN RESOLVER OUTPUT

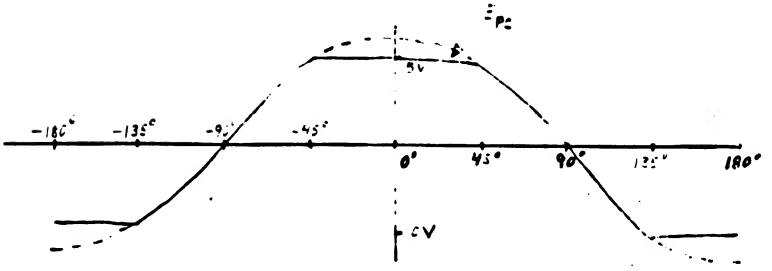


FIGURE 152-2. COS RESOLVER OUTPUT

The inner gimbal angle is determined by using measurements G 2112 and G 2113. First the measurements are used to determine the quadrant. Then the sine measurement is compared with the input for the sine 45^{o}. If the measurement is less than the sine 45^{o} (input), the sine is used to determine the angle θ. If the sine measurement is greater than the sine 45^{o} (input), then the cosine measurement is used to determine the angle θ. Since the calibrated data covers only the first quadrant it may be necessary to complement the PCM value in order to obtain a count in the first quadrant. It should be noted that there are five (5) straight line segments which are used for the conversion from counts to degrees for the sin and five (5) segments for the cos in the first quadrant. After the angle is determined it is corrected for quadrant and displayed on the CRT.

Measurements G 2142 and G 2143 are used to determine the middle gimbal angle in the same manner as described above.

Also using the same method, measurements G 2172, and G 2173 are used to find the outer gimbal angle.

Since each of the six measurements are 10 samples per second and the CRT is updated once a second, the last sample each second is used to determine the value of the angle to be displayed.

Operator Action: Control Room Operator: No activity required

Spacecraft Operator: No activity required

Uplink Requirements:

None

Downlink Requirements:

Measurement ID: The six measurements are listed under Input data.

Range: Each angle has the range of $\pm$ 180°.

CRT Display: Each angle will be displayed to the nearest degree. The CRT format is as specified in the programming requirements document for the vehicle to be tested.

Filing Requirements: None required

Remarks:

Flow Chart Definitions:

$(SIN\theta)_8$ - Incoming PCM value for the SIN measurement

$(COS\theta)_8$ - Incoming PCM value for the COS measurement

CIS_1 - Calibration input for SIN measurement at point 1 (i.e., 0° for SIN).

CIC_1 - Calibration input for COS measurement at point 1 (i.e., 90° for COS).

CIS_6 - Calibration input for SIN measurement at point 6 (ie.e., 45°)

CIC_6 - Calibration input for COS measurement at point 6 (i.e., 45°).

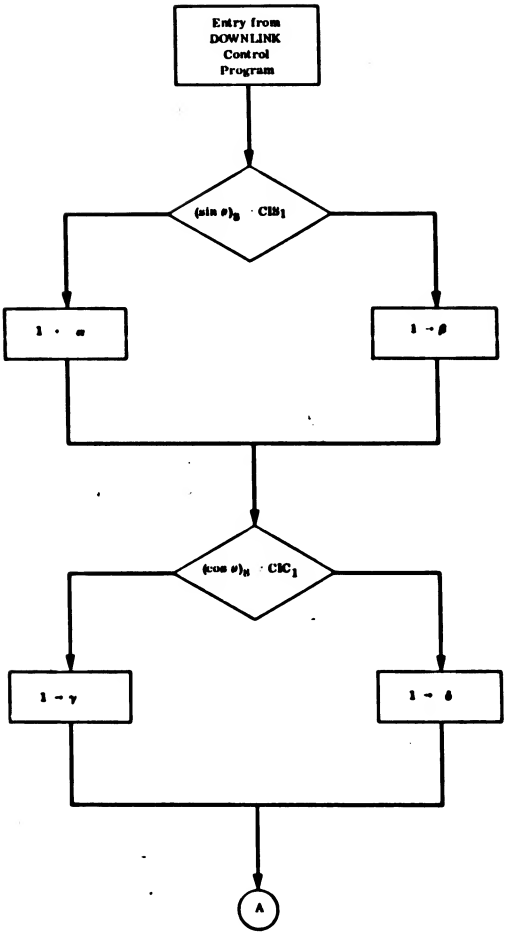


Figure 152-3 (1 of 3)

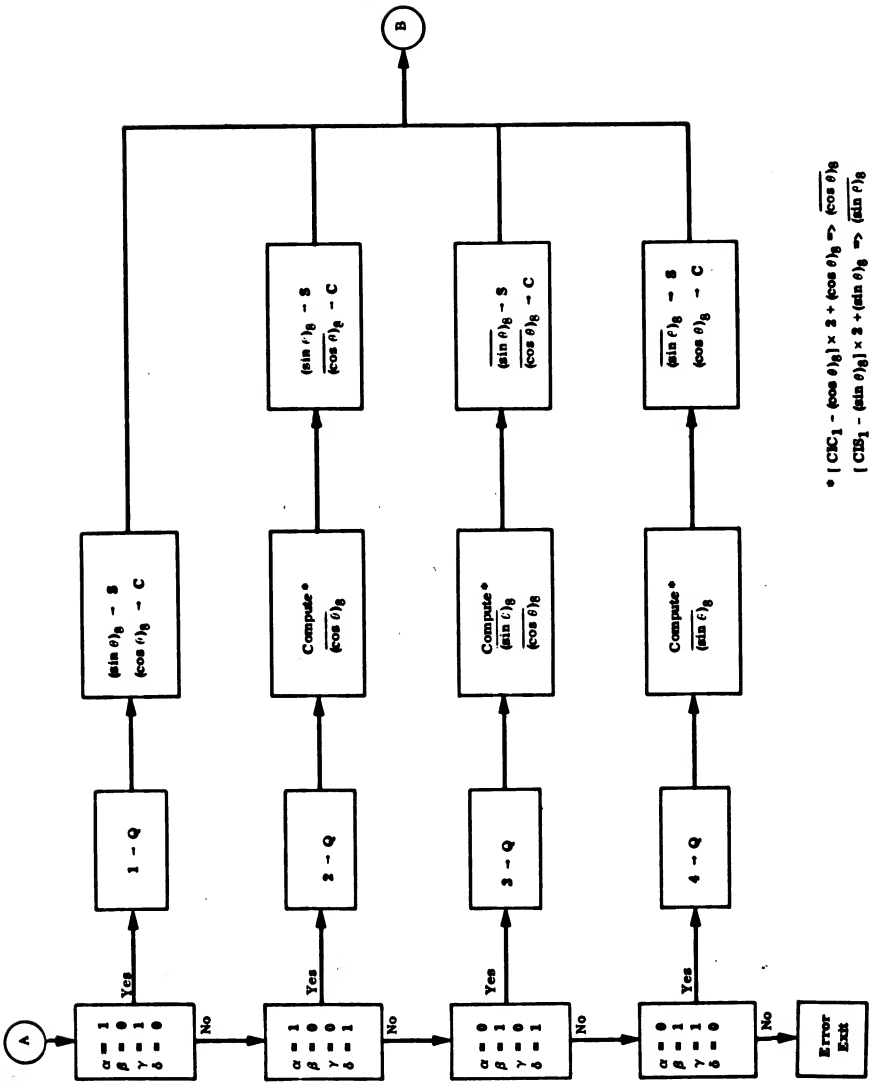


Figure 152-3 (2 of 3)

4-152.6

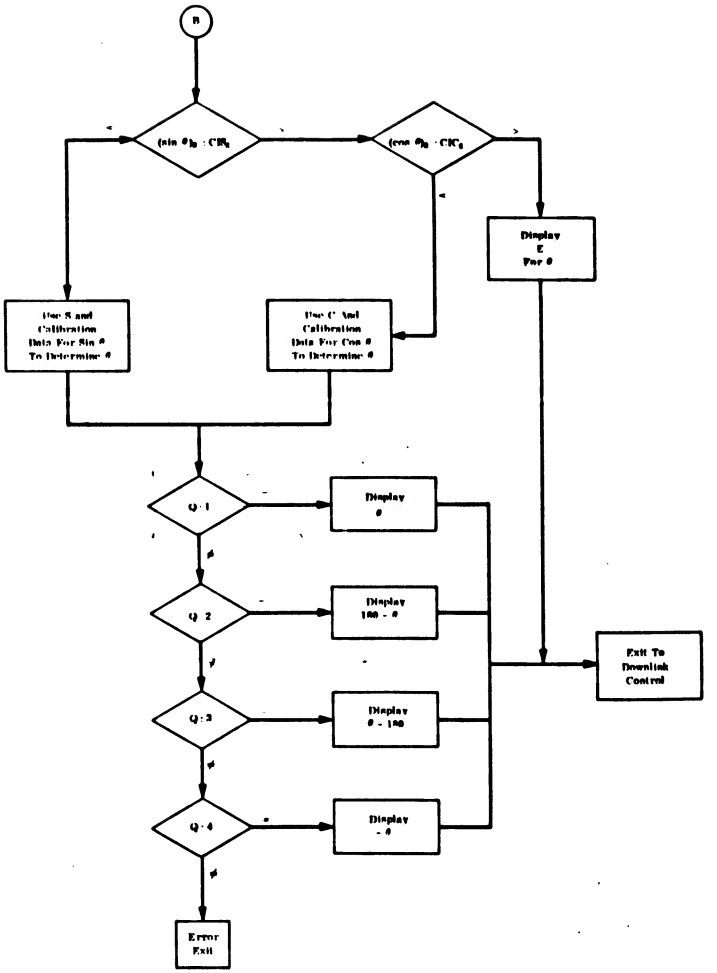


Figure 152-3 (3 of 3)

Title: ACE-S/C Error Reset Program G&N 171

Part Of: Downlink Program

Purpose: This subprogram resets the error displays on the CRT display unit to give a "no error" indication for the ACE-S/C subprograms utilized with the Block I G&N system. These error displays allow monitoring of the ACE system operation during G&N system test.

Calling Sequence: Entry: This subprogram operates under executive control and is initiated from R-START module specified in the PRPS.

Exit: Return to Downlink Executive Program after error displays are reset.

Computation Sequence:

The error displays reset by this subprogram are listed below, along with the ACE-S/C subprogram that generates them during its operation. The CRT page and line location for each error display is detailed in the Program Requirements Process Specification.

G&N Program No.	Error Indication
101	TIME ERROR (1)
102	TIME ERROR (2 or 4)
103	TIME ERROR (3)
121	WORDERR (1 or 2)
G&N Program No.	Error Indication
	MARKERR (1 or 2)
	SYNCERR (2 or 3)
122	RELERR (1)
131	PARERR (1)
	KEYERR (1)
132	VERROR (1, 2, 3, 4, or 5)
181	FSERR (1)

Each error display consists of a variable segment (underlined) which signifies the type of error condition occuring in a particular ACE program, and a fixed title segment. When initiated by the operator, this subprogram will blank out the variable segments of the error displays.

Operator Action: Console Operator: Operator action is required to initiate this subprogram via the R-START module.

Spacecraft Operator: No activity required

Uplink Requirements:

The ACE Uplink System is not utilized.

Downlink Requirements:

PCM data stream is not required by this subprogram.

Title: PIPA Switching and Stabilization Loop Response Test G&N 181

Part Of: Uplink Program

Purpose: This program enables a step voltage input into the stabilization loop, for the stabilization servo loop response test, and display of the PIPA signal generator outputs.

Calling Sequence: Entry:

1) This subprogram will operate under executive control and is initiated from an R-START Module specified in the PRPS for the stabilization loop response test.

2) This subprogram is also initiated via a specified R-START Module to allow monitoring of the PIPA signals.

Data: Input to this subprogram is supplied by the CUE upon R-Start execution. This data includes the start module address and the status of the function switches.

Output from this subroutine consists of a series of relay command words.

Normal Exit: Return to Uplink Executive Program.

Error Exit: CRT error display and Uplink Command Tape recording, prior to transfer to the Uplink Executive Program.

Computation Sequence:

Upon R-START execution, this subprogram checks to determine if more than one function switch has been depressed. If so, this program generates an error message for display and recording purposes, blanks out current CRT display and transfers control to the Uplink Executive Program.

The subprogram also checks to see that there was no more than one change in state from the function switches at the previous XEQ. If there has been more than one state this program generates an error message for Uplink Command Filing and transfers control to the Uplink Executive Program without transmitting relay command words Uplink.

A single function switch depression, with only one change of state present, enables the assembly and transmission of relay command words. Refer to the Vehicle Program Requirements Process Specifications for R-START function switch setting and DTCS addresses.

Operator Action: Console Operator: R-START execution is required to initiate this subprogram as given below.

A) Stabilization Loop Step Input

1) The intended status of the relays is selected by depression of the function switches.

2) The step input is applied to the particular IRIG upon depression of the XEQ switch.

3) The removal of the step input is accomplished by again depressing the function switch so that no switches are illuminated, followed by the XEQ switch.

NOTE: When selecting a series of step inputs, item 3) should always be used to insure that the bank of relays are reset, prior to selecting a new step input.

B) PIPA Signal Display

The operator action required for this function is similar to that described for the stabilization loop step input, with the exception of the R-START module location. Only one PIPA signal is displayed at a time and is accomplished by means of the function switch selection as given under Computation Sequence. To remove the PIPA display requires that the operator depress the function switch again and then the XEQ switch.

Spacecraft Operator: No activity required.

Uplink Requirements:

DTCS Transmission: A twenty-four bit command word is compiled in the Uplink computer containing the "carry-on" relay address and the relay status.

DTCS Stimuli: The relay addresses are listed in the Vehicle PRPS.

Transmission Time: During G&N system test, the sequence of subprogram initialization, will be specified in the "Operational Checkout Procedures". All other times, the transmission time will be as required.

Filing Requirements: The complete command history is recorded on the Uplink Command tape.

Downlink Requirements:

CRT Display

1) A display occurs to identify a particular PIPA measurement, appearing on the oscilloscope. The display consists of the following format:

"PIPA MEAS. XXX"

where XXX = REF, X, Y or Z.

The variable portion of the format (underlined) will appear upon operator selection of a PIPA measurement. This display will be blanked when operator action removes this selection by means of the function switches.

2) An error indication is displayed in the following format "FSERR 1". Refer to the "Program Requirements Process Specification" for details on CRT page and line information.

Title: G&N Downlink Edit Program - Block II and LEM

Program Number: G&N No. 210

Purpose: The G&N Downlink Edit Program strips outs, interprets and presents all or any part of the Command Guidance Computer (CGC) and the LEM Guidance Computer (LGC) data recorded on the PCM Data Tape.

Input: The inputs to this program are:

1) PCM Data Tape or Compressed Data Tape containing CGC/LGC data.
2) Edit Parameters (cards or tape)
3) Control cards

Output: The output from this program is a printed listing of CGC/LGC Downlink data taken from the PCM Data tape or CDT for the intervals requested and processed and displayed in the manner defined by the Edit Parameters.

General Program Description: The G&N Downlink Edit-Block II is divided into two segments to minimize the impact of changes in the input data format. The two segments are:

1) EXECUTIVE SEGMENT - This segment prepares the Edit Parameters for use, processes the Control Cards, extracts the CGC/LGC data from the PCM Data tape or CDT for the intervals defined, validates this data and transmits it to the next segment.

2) PRESENTATION SEGMENT - This segment receives the CGC/LGC data and the Edit Parameters from the Executive Segment and processes and prints out this data in the manner prescribed by the Edit Parameters.

Printing: Printing will be once every complete cycle through the Downlink list. The Downlink Edit Format Tables will define either an entire page to be printed (over 6 lines per ID) or a subpage (6 lines or less) to be printed under line count control.

Execution: In most cases, it will not be necessary to see all the data on the PCM Data Tape or CDT. The intervals to be processed will be specified in the Zulu Time as it appears on the PCM Data Tape or CDT and will be input to the program on control cards.

Data Rate: CGC/LGC Data is recorded on analog PCM Data Tapes at bit rates of:
1) 204.8KBS
2) 51.2KBS
3) 1.6KBS
This program must be able to process data at any and all of these rates.

WORD COUNT from 621	DISPLAY WORD ACTION
79, 82 or 84	Bit 11 of these display words is interpreted as follows:
bit 11 = 1	Set sign indicator of R to minus.
bit 11 = 0	Set sign indicator of R to blank.

In both cases the program continues to region 1.

NOTE: Words with word counts 84 and 85 set the sign of R1; words with word counts 82 and 83 set the sign of R2; words with word counts 79 and 80 set the sign of R3.

Region 1 - extracts the relay code corresponding to bits 10-6 of the Downlink word and checks it against Table 622-2 for legality. If the code is legal the indicator is set to display the digit from Table 622-2 followed by a transfer to Region 2. If the code is not legal clear the sign display indicator and initiate a relay-error exit.

Region 2 - extracts the relay code corresponding to bits 5-1 and checks it against Table 622-2 for legality. If the code is legal the indicator is set to display the digit from Table 622-2 followed by a return to the ACE Executive Program. If the code is not legal clear the sign and first digit display indicators and initiate a relay-error exit.

Filing Requirements: (Applicable until the Downlink File capability is removed.)

Upon detection of an error the appropriate records should be made on the file tape. These are given in Table 622-3.

An R-START is to be used to transcribe the entire display on the file tape. This R-START will be interrogated after the processing of the 11th display word (word count = 89). If the R-START is selected and the display has changed since the last recording, the entire display is to be recorded (including FLASH and UPLINK indicators). If either the R-START is not selected or the display has not changed, no recording should be made. The recording should be prefaced by '622 Display Recording'.

Display Requirements: The CRT Displays required in error conditions are given in Table 622-3. They and the DSKY CRT displays will be formatted on the pages defined in the ACE Requirements Specification.

16 BIT GC DOWNLINK DISPLAY WORD

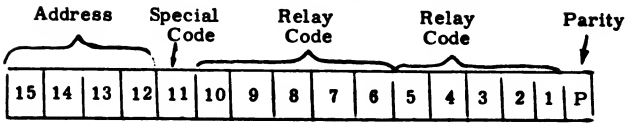


Figure 622-1

DISPLAY WORD EXAMPLE

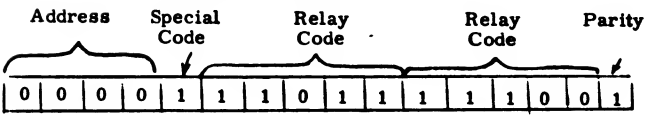


Figure 622-2

Table 622-1

Table of DISPLAY Words

Associated Word Count	Address Bits 15-12 Binary Code	Special Code Bit 11	Display Name Relay Code for Bits 10-6	Display Name Relay Code for Bits 5-1
89	N	--	MD1	MD2
88	O		VD1	VD2
87	T	--	ND1	ND2
86			--	R1D1
85	U	+ R1	R1D2	R1D3
84	S	- R1	R1D4	R1D5
83	E	+ R2	R2D1	R2D2
82	D	- R2	R2D3	R2D4
81		--	R2D5	R3D1
80		+ R3	R3D2	R3D3
79		- R3	R3D4	R3D5

Table 622-2

5 Bit Relay Codes for Numeric Character Display

BLANK	00000
0	10101
1	00011
2	11001
3	11011
4	01111
5	11110
6	11100
7	10011
8	11101
9	11111

Table 622-3

ERROR DESCRIPTION

ERROR	CRT DISPLAY	STANDARD MESSAGE ON FILE TAPE
A word has appeared containing a relay code which is not in Table 622-2.	RELERR1	622 RELERR1, 16-bit word, time tag, and ID code

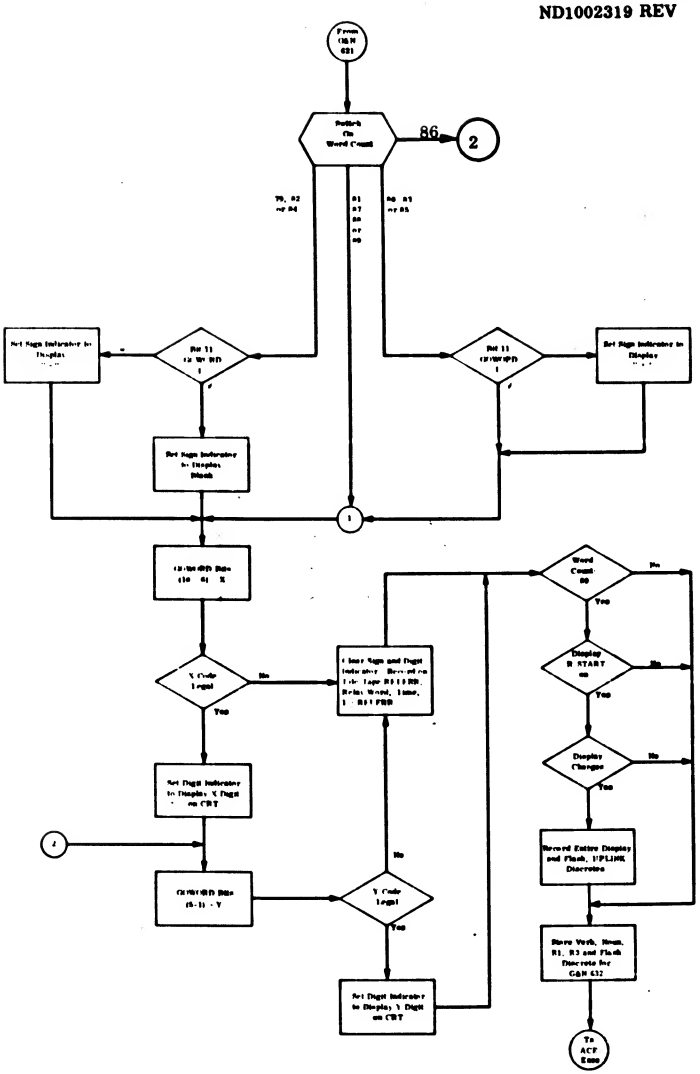


Figure 622-3

Title: LGC Downlink Interpretation Program, LEM G&N 624

Part Of: Downlink Program

Purpose: This subprogram defines the interpretation of the LGC Downlink Data which is required for ACE-S/C console operator usage and information. Four downlists are to be processed by this subprogram for post-installation testing. The second word of the identification group for all downlists is identical, i.e., 00437_8. Lists with a first ID word of 00321_8 or 01610_8 shall be processed entirely as described in Table 624-1. For lists with the first ID word 01437_8 or 00001_8, words 3 through 76 should not be processed, but words 1, 2, and 77 through 100 should be processed as described in Table 624-1.

Calling Sequence: Entry: This subprogram is activated by the LGC Downlink Format Program, G&N 621, whenever the format Program is processing Downlink Data.

Data Input: Input from G&N 621 to the Downlink Interpretation Program consists of a 16-bit LGC Downlink Data Word. Two types of LGC words will be processed by G&N 624:

1) Identification: This word specifies the data list which is being received by G&N 624.

2) Data: Actual LGC data words. The position in the list identifies the data being processed.

Data Output: Output will consist of CRT displays and processed parameters stored in temporary buffers for use by other ACE-S/C G&N Subprograms.

Normal Exit: Return to ACE Executive Program which will supply more data to G&N 621.

Error Exit: None.

Computation Sequence: The downlink list for the LGC is transmitted once per second and consists of 100 words (two per prime frame). Each prime frame consists of five 8-bit PCM words which contain a 1-bit word order code, two 16-bit LGC words and seven extra (0) bits:

		BIT						
WORD 1	WOC	S/15	14	13	12	11	10	9
WORD 2	8	7	6	5	3	3	2	1
WORD 3	P	S/15	14	13	12	11	10	9
WORD 4	8	7	6	5	4	3	2	1
WORD 5	P	0	0	0	0	0	0	0

The Word Order Code (WOC) is 0 for an ID word and 1 for data words.

P is a Parity Bit

S is a Sign Bit

Table 624-1 describes the contents of the list and provides the processing requirements for each word.

Operator Action: None

Uplink Requirements: None

Downlink Requirements: CRT Display: The ACE-S/C Programming Requirements Documents contain the CRT scope and line information associated with displays referenced in this subprogram specification.

Filing Requirements: None.

TABLE 624-1

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION See Note ()	DISPLAY	SCALE FACTOR
1	ID	1-15	Display in OCTAL	IDWD1 XXXXX	N/A
2	ID	1-15	Display in OCTAL	IDWD2 XXXXX	"
3	PIPA X	1-15	Convert to Decimal	PIPA X ± XXXXX	1
4	PIPA Y	1-15	" " "	PIPA Y ± XXXXX	1
5	PIPA Z	1-15	" " "	PIPA Z ± XXXXX	1
6	RHCP	1-15	None	N/A	N/A
7	RADMODES	1	None	N/A	N/A
7	"	2	(b)	IGN RR CDU FAIL ON (OFF)	"
7	"	3	None	N/A	"
7	"	4	(a)	RR DATA FAIL ON (OFF)	"
7	"	5	(a)	LR ALT FAIL ON (OFF)	"
7	"	6-7	None	N/A	"
7	"	8	(a)	LR VEL FAIL ON (OFF)	"
7	"	9-10	None	N/A	"
7	"	11	(a)	RR ANT OUT ON (OFF)	"
7	"	12	(a)	RR ANT MODE 2 (1)	"
7	"	13	(b)	IGN RR CDU FAIL ON (OFF)	"
7	"	14	(a)	RR ANT REMD ON (OFF)	"
7	"	15	(a)	CONT DESIG ON (OFF)	"
8	SAMPLIN	1-15	None	N/A	"
9	OLDAT AGD	"	"	"	"
10	DESCOUNT	"	"	"	"
11	SAMPLSUM	"	"	"	"
12	" + 1	"	"	"	"
13	OPTYHOLD	"	"	"	"
14	" + 1	"	"	"	"
15	TIMEHOLD	"	"	"	"
16	" + 1	"	"	"	"
17	ALTTUDE	"	"	"	"
18	" + 1	"	"	"	"
19	ALTRATE	1-15	Convert to Decimal	ALT RATE ±XXXX.X FPS	0.5 FPS
20	FINALT	1-15	None	N/A	N/A
21	ALTSAVE (MS)	1-15	(c) Convert to Decimal	ALT SAVE ±XXXXXX.XXX FT	2.345 FT
22	ALTSAVE + 1(LS)	1-15			
23	FINALT (MS)	1-15	(c) Convert to Decimal	FIN ALT ±XXXXXX.XXX FT	2.345 FT
24	FINALT + 1 (LS)	1-15			
25	FORVEL	1-15	Convert to Decimal	FORVEL ±XXX.XX FPS	0.5571 FPS
26	LATVEL	1-15	Convert to Decimal	LATVEL ±XXX.XX FPS	0.5571 FPS
27	CDUX	1-15	" " "	CDUX ±XXX.XX DEG	$180/2^{14}$ DEG

TABLE 624-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION (See Note ()	DISPLAY	SCALE FACTOR
28	CDU Y	1-15	Convert to Decimal	CDU Y ±XXX.XX DEG	$180/2^{14}$ DEG
29	CDU Z	1-15	" " "	CDU Z ±XXX.XX DEG	"
30	OPTY	1-15	None	N/A	N/A
31	RR TRUN	1-15	Convert to Decimal	RR TRUN ±XXX.XX DEG	$180/2^{14}$ DEG
32	RR SHAFT	1-15	" " "	RR SHAFT ±XXX.XX DEG	"
33	STATE	1-15	None	N/A	N/A
34	STATE + 1	1-15	"	"	"
35	STATE + 2	1-15	"	"	"
36	STATE + 3	1-15	"	"	"
37	REDO CTR	1-15	Convert to Decimal	REDO CTR XXXXX	1
38	FAIL REG	1-15	Display in Octal	FAIL REG XXXXX	N/A
39	LMPCMD	1-15	" " "	LMPCMD XXXXX	N/A
40	IMODES30	1	(d)	IGN PIP FAIL ON (OFF)	N/A
40	"	2	None	N/A	N/A
40	"	3	(a)	IGN I-CDU FAIL ON (OFF)	"
40	"	4	(a)	IGN IMU FAIL ON (OFF)	"
40	"	5	(d)	IGN PIP FAIL ON (OFF)	"
40	"	6	(a)	INITIALIZE ISS ON (OFF)	"
40	"	7-15	None	N/A	"
41	LAST Y CMD	1-15	None	N/A	"
42	LAST X CMD	1-15	"	"	"
43	TANG	1-15	"	"	"
44	TANG + 1	1-15	"	"	"
45	THETAD	1-15	"	"	"
46	THETAD + 1	1-15	"	"	"
47	THETAD + 2	1-15	"	"	"
48	DELVX	1-15	"	"	"
49	MARKSTAT	1-15	"	"	"
50	XY MARK	1-15	"	"	"
51	DRIFT 0	1-15	Convert to Decimal	VDRIFT 0 ±XXX.XX MERU	$1000/2^{14}$ MERU
52	DRIFT 0 + 1	1-15	None	N/A	N/A
53	DRIFT 1	1-15	Convert to Decimal	SDRIFT 1 ±XXX.XX MERU	$1000/2^{14}$ MERU
54	DRIFT 1 + 1	1-15	None	N/A	N/A
55	DRIFT 2	1-15	Convert to Decimal	EDRIFT 2 ±XXX.XX MERU	$1000/2^{14}$ MERU
56	DRIFT 2 + 1	1-15	None	N/A	N/A
57	TORQUE 0	1-15	None	N/A	N/A
58	TORQUE + 1	1-15	None	"	"
59	ANG Z	1-15	Convert to Decimal	ANG Z ±XXXXX	1.0

TABLE 624-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION See Note ()	DISPLAY	SCALE FACTOR
60	ANG Z + 1	1-15	None	N/A	N/A
61	ANG Y/PIPA N		Display in Octal	ANG Y/PIPA N XXXXX	"
62	ANG Y + 1		None	N/A	"
63	ANG X/PIPA E		Display in Octal	ANG X/PIPA E XXXXX	"
64	ANG X + 1		None	N/A	"
65	V LAUN		None	N/A	"
66	V LAUN + 1		None	"	"
67	V LAUN + 4		None	"	"
68	V LAUN + 5		None	"	"
69	R STACK (MS)	1-15	(c),(e) Convert to Decimal	RR RANGE ±XXXXXXXXX.XXX FT	+9.38 FT
70	R STACK + 1 (LS)	1-15		LR VX ±XXXXXXXX.XXXXX FPS	+0.6435 FPS
71	R STACK + 6 (MS)	1-15	(c),(e) Convert to Decimal	RR RANGE RATE ±XXXXXXXX.XXXX FPS	+0.6278 FPS
72	R STACK + 7 (LS)	1-15		LR VY ±XXXXXXXX.XXXXX FPS	+1.2525 FPS
73	R STACK +12D(MS)	1-15	(c) Convert to Decimal	LR VZ ±XXXXXXXX.XXXXX FPS	+0.8571 FPS
74	R STACK +13D (LS)	1-15			
75	R STACK +18D(MS)	1-15	(c) Convert to Decimal	LR ALT ±XXXXXXXXX.XXXXXFT	+1.079 FT
76	R STACK +19D(LS)	1-15			
77	UPLOCK	1	(a)(f)	UPLOCK ON (OFF)	N/A
77	UPLOCK	2-15	None	N/A	N/A
78	T6LOC		None	"	"
79	DSPTAB + 0	1-15	"	"	"
80	DSPTAB + 1	1-15	"	"	"
81	DSPTAB + 2	1-15	"	"	"
82	DSPTAB + 3	1-15	"	"	"
83	DSPTAB + 4	1-15	"	"	"
84	DSPTAB + 5	1-15	"	"	"
85	DSPTAB + 6	1-15	"	"	"
86	DSPTAB + 7	1-15	"	"	"
87	DSPTAB + 8	1-15	"	"	"
88	DSPTAB + 9	1-15	"	"	"
89	DSPTAB + 10	1-15	"	"	"
90	DSPTAB + 11	1-3	None		
90	DSPTAB + 11	4	(a)	NO ATTITUDE ON (OFF)	
90	DSPTAB + 11	5	None	N/A	
90	DSPTAB + 11	6	(a)(f)	GIMBAL LOCK ON (OFF)	
90	DSPTAB + 11	7	None	N/A	
90	DSPTAB + 11	8	(a)	TRACKER FAIL ON (OFF)	

TABLE 624-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION See Note ()	DISPLAY	SCALE FACTOR
90	DSPTAB + 11	9	(a)	PROGRAM ALARM ON (OFF)	N/A
90	DSPTAB + 11	10-15	None	N/A	"
91	TIME 2 (MS)	1-15	(g)(c) Convert to Decimal	LGC TIME XXXX.XXXXX	1/360000
92	TIME 1 (LS)	1-15			
93	CHNL 11	1	(a)	ISS WARNING ON (OFF)	N/A
93	"	2	(i)	COMPUTER	"
93	"	3	(i)	UPLINK	"
93	"	4	(a)	TEMP CAUTION ON (OFF)	"
93	"	5	(a)	KEY RELEASE ON (OFF)	"
93	"	6	(a)(h)	FLASH VERB-NOUN ON (OFF)	"
93	"	7	(a)(f)	OPERATOR ERROR ON (OFF)	"
93	"	8-12	None	N/A	"
93	"	13	(a)	ENGINE ON ON (OFF)	"
93	"	14	(a)	ENGINE OFF ON (OFF)	"
93	"	15	None	N/A	"
94	CHNL 12	1	(a)	ZERO RR CDUS ON (OFF)	"
94	"	2	"	RR ERR CNTR ON (OFF)	"
94	"	3	"	HORIZ VEL ON (OFF)	"
94	"	4	"	COARSE ALIGN ON (OFF)	"
94	"	5	"	ZERO ISS CDUS ON (OFF)	"
94	"	6	"	ISS ERR CNTR ON (OFF)	"
94	"	7	"	N/A	"
94	"	8	"	CDU CONTROL ON (OFF)	"
94	"	9	"	+ PITCH TRIM ON (OFF)	"
94	"	10	"	- PITCH TRIM ON (OFF)	"
94	"	11	"	+ ROLL TRIM ON (OFF)	"
94	"	12	"	- ROLL TRIM ON (OFF)	"
94	"	13	"	LR POS2 CMD ON (OFF)	"
94	"	14	"	RR LOCKON ABLE ON (OFF)	"
94	"	15	"	ISS TURNON COMP ON (OFF)	"
95	CHNL 13	1-4	None	N/A	"
95	"	5	(a)	INHIBIT UPLINK ON (OFF)	"
95	"	6-9	None	N/A	"
95	"	10	(a)	TEST ALARMS ON (OFF)	"
95	"	11	(a)	ABL LGC STBY ON (OFF)	"
95	"	12-15	None	N/A	"
96	CHNL 14	1	None	N/A	"
96	"	2	(a)	ALT RATE SEL ON (OFF)	"

TABLE 624-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION See Note ()	DISPLAY	SCALE FACTOR
96	CHWL 14	3	(a)	ALT METER ACT ON (OFF)	N/A
96	"	4	(a)	THRUST DRV ON (OFF)	"
96	"	5-15	None	N/A	"
97	CHWL 30	1	(a)	ABORT OFF (ON)	"
97	"	2	"	STAGE VERIF OFF (ON)	"
97	"	3	"	ENG ARMED OFF (ON)	"
97	"	4	"	ABORT STAGE OFF (ON)	"
97	"	5	"	AUTO THROT OFF (ON)	"
97	"	6	"	DSP INRTL DATA OFF (ON)	"
97	"	7	"	RR CDU FAIL OFF (ON)	"
97	"	8	"	No Display Required	"
97	"	9	(a)(f)	IMU OPERATE OFF (ON)	"
97	"	10	(a)	G&N CNTL LEM OFF (ON)	"
97	"	11	"	IMU CAGE OFF (ON)	"
97	"	12	"	ISS CDU FAIL OFF (ON)	"
97	"	13	"	IMU FAIL OFF (ON)	"
97	"	14	"	ISS TURNON RQST OFF (ON)	"
97	"	15	"	TEMP IN LIM OFF (ON)	"
98	CHWL 31	1	(a)	+EL LPD, +PMI OFF (ON)	"
98	"	2	"	-EL LPD, -PMI OFF (ON)	"
98	"	3	"	+YMI OFF (ON)	"
98	"	4	"	-YMI OFF (ON)	"
98	"	5	"	+AZ LPD, +RMI OFF (ON)	"
98	"	6	"	-AZ LPD, -RMI OFF (ON)	"
98	"	7	"	+X TRANS OFF (ON)	"
98	"	8	"	-X TRANS OFF (ON)	"
98	"	9	"	+Y TRANS OFF (ON)	"
98	"	10	"	-Y TRANS OFF (ON)	"
98	"	11	"	+Z TRANS OFF (ON)	"
98	"	12	"	-Z TRANS OFF (ON)	"
98	"	13	"	ATTITUDE HOLD OFF (ON)	"
98	"	14	"	AUTO MODE OFF (ON)	"
98	"	15	"	ATT CMDR DETENT OFF (ON)	"
99	CHWL 32	1	(a)	JETS 2-4 FAIL OFF (ON)	"
99	"	2	"	JETS 5-8 FAIL OFF (ON)	"
99	"	3	"	JETS 1-3 FAIL OFF (ON)	"

TABLE 624-1 (Continued)

WORD NUMBER	WORD NAME	BIT(S)	DATA MANIPULATION See Note ()	DISPLAY	SCALE FACTOR
99	CHNL 32	4	(a)	JETS 6-7 FAIL OFF (ON)	N/A
99	"	5	"	JETS 14-16 FAIL OFF (ON)	"
99	"	6	"	JETS 13-15 FAIL OFF (ON)	"
99	"	7	"	JETS 9-12 FAIL OFF (ON)	"
99	"	8	"	JETS 10-11 FAIL OFF (ON)	"
99	"	9	"	PITCH GIM OFF (ON)	"
99	"	10	"	ROLL GIM OFF (ON)	"
99	"	11-15	None	N/A	"
100	CHNL 33	1	None	N/A	"
100	"	2	(a)	RR ON/AUTO OFF (ON)	"
100	"	3	"	RR RANGE LO-SC OFF (ON)	"
100	"	4	"	RR DATA GOOD OFF (ON)	"
100	"	5	"	RR ALT D GOOD OFF (ON)	"
100	"	6	"	LR POS 1 OFF (ON)	"
100	"	7	"	LR POS 2 OFF (ON)	"
100	"	8	"	LR VEL D GOOD OFF (ON)	"
100	"	9	"	LR ALT LO-SC OFF (ON)	"
100	"	10	"	BLOCK UPLINK OFF (ON)	"
100	"	11	"	UPLINK TOO FAST OFF (ON)	"
100	"	12	"	DWNLK TOO FAST OFF (ON)	"
100	"	13	"	PIPA FAIL OFF (ON)	"
100	"	14	"	LGC WARNING OFF (ON)	"
100	"	15	"	OSC ALARM OFF (ON)	"

TABLE 624-1 (Continued)

NOTES:

N/A - Not Applicable.

(a) - If the bit indicated equals one, display the word underlined. If the bit indicated equals zero, display the word in parentheses.

(b) - If either bit equals one, display the word underlined. If both bits are zero, display the word in parentheses.

(c) - Combine the 14 magnitude bits of the most significant (MS) part with 14 magnitude bits of the least significant part(LS). The decimal conversion should be made only after the two parts of the double precision word have been sign checked. The signs appear in bit 15 of each word. See "Remarks" for a method for handling double precision words.

(d) - Same as (b).

(e) - NOTE: This double precision word must be scaled two ways each of which is displayed.

(f) - Store bit status for G&N 631.

(g) - Store values for G&N 602.

(h) - Store bit status for G&N 622 and 632. If the indicated bit is a one, set the SGS Discrete for VERB-NOUN FLASH. If the bit is zero, clear the discrete.

(i) - If the bit indicated equals one, set the SGS Discrete that displays the word in the display column. If the bit equals zero, remove the appropriate SGS Discrete.

REMARKS:

Method of Handling Double Precision LGC Downlink Words

Figure 624-1 is a flow diagram of a scheme for handling the double precision (DP) LGC downlink words. Each word consists of a sign bit (the high order bit), fourteen data bits and a parity bit (low order bit) for odd parity. The downlink words A and B may be in one of four conditions; plus zero (00000_8), minus zero (77777_8), positive non-zero or negative non-zero.

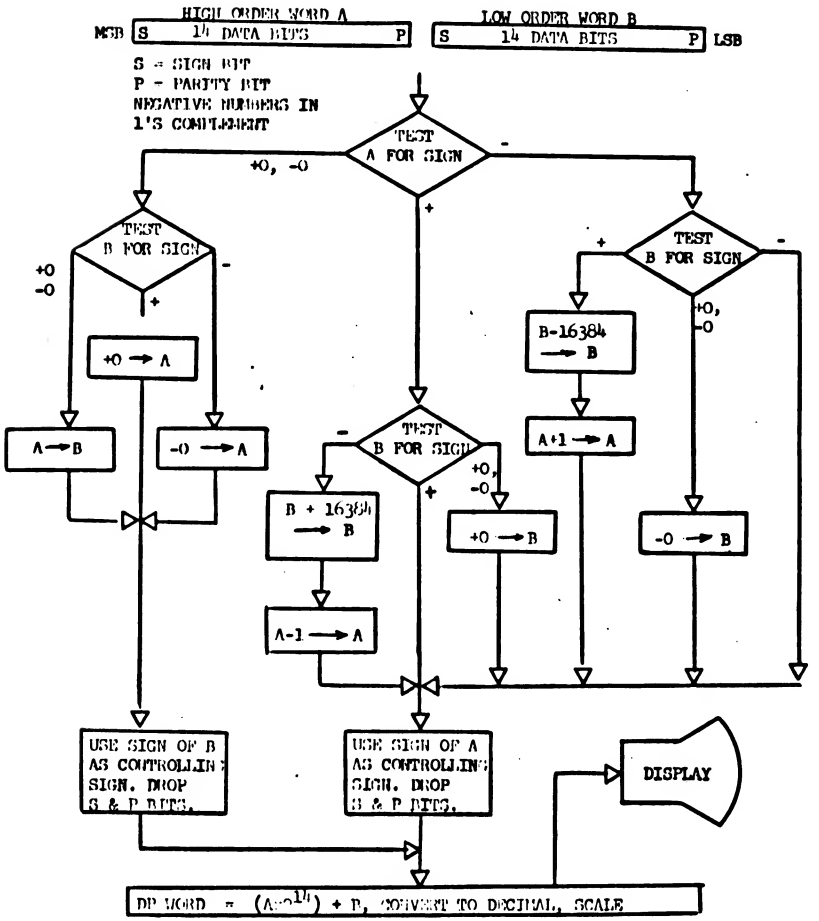
Tests are made on the sign and magnitude of A, and depending on the results, similar tests are made on B as outlined in Figure 624-1. In the cases where A is plus or minus zero, the sign of B shall be the controlling sign.

In cases where A is non-zero and B is of opposite sign, the conversions to A and B are made as shown in Figure 624-1, thereby forcing the sign of B to agree with the sign of A.

Prior to combining the DP words into a single quantity, the S and P bits are dropped. Converted B is then added to converted A X 2^{-14}, and the resulting 28 bit word is converted to decimal, scaled and displayed on CRT with a sign as specified in the flow diagram.

FIGURE 624-1

METHOD OF HANDLING DOUBLE PRECISION LGC DOWNLINK WORDS



Title: K-START Module Program G&N 631

Part Of: Uplink Program

Purpose: This subprogram accepts data input in the form of GC keycodes from the punched tape reader or the keyboard, via the K-START module. These keycodes are checked for correct parity and valid codes and then formatted into a command word for eventual transmission to the External DTCS. The status of the Uplink system and the GC is monitored, and the Uplink command sequence is controlled, to the acceptable input rate of the GC.

Calling Sequence: Entry: This subprogram operates under Uplink Executive Program control and will be initiated from K-START module.

Data: This consists of information received either from K-START punched tape, (the automatic mode) or from the K-START keyboard (the manual mode). The data content utilized by this subprogram consists of a five bit keycode plus a parity level.

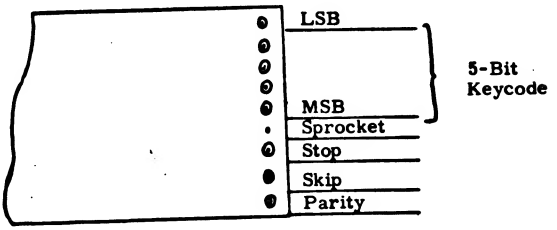
Normal Exit: Return to Uplink Executive Program

Error Exit: Error conditions will be displayed for the operator on the CRT and recorded on the Command Tape. Those error conditions are subsequently described in Table 631-1.

Computation Sequence:

This subprogram is initialized upon operator action by means of the K-START module, either in manual or automatic modes. A five bit keycode (see Table 631-2) as previously mentioned is generated by internal logic upon depression of a keyboard switch or by punched tape input via the tape reader. A transfer to G&N 632 takes place if an R-START module execute is detected.

The format of the paper tape entry is shown below.



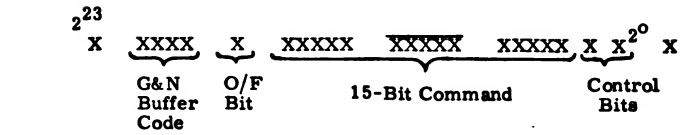
During keyboard entry, the stop and skip positions will contain zeroes and the parity bit is generated internally upon depression of the keyboard switch.

Once a keycode is received by G&N 631, no other data is allowed into this subroutine until so commanded, to ensure that the GC receives Uplink commands at the correct transmission frequency. The keycode is checked with the parity bit to assure that odd parity exists. In the event of a parity error, a CRT display occurs, combined with the "non-verify" lamp display to inhibit further entry through the K-START module. A normal Command Tape recording occurs for post test analysis. If parity is odd, a check is made on the validity of the received keycode, by means of table look-up. A CRT display occurs with a "non-verify" light to indicate an invalid keycode and to inhibit further commands. A normal Command Tape recording occurs for post test analysis.

A valid keycode is then transformed into a 16-bit GC Uplink Word format and combined with the DTCS G&N buffer address

and required control bits as shown below.

G&N UPLINK WORD FORMAT



Prior to transmittal of a sequence of command words, a sequence of tests are made on the incoming keycodes to determine if the command sequence contains a V36, V40 or V42. If so, two GC discretes are monitored, namely the "Gimbal Lock" and the "IMU Operate". If both discretes are set to a "one" state, then a "non-verify" display will occur on the K-START and the next keycode will not be transmitted Uplink. Another discrete is monitored, the "Operator Error" flashing discrete (Channel 11, bit 7). An error status will cause this subprogram to terminate the processing of GC commands by inhibiting further K-START data entry with a "non-verify" signal. A normal system recording will occur on the command tape as specified in Table 631-1.

The final discrete tested is GC word UPLOCK, bit 1. A "one" state will result in a test for an "alarm reset" keycode. If this code is available, then two commands will be transmitted at the correct frequency. The first command will zero the GC Uplink register and the second, namely, the "reset" keycode will possibly reset the alarm indication triggered by UPLOCK, bit 1. The "zero" state for this discrete, will allow the subprogram to continue and transmit the commands to the GC with subsequent recordings on the command tape.

The K-START module is sealed after receipt of a keycode, to allow the correct transmission frequency to the GC to be utilized. The sealing can occur as soon as a "good" CSR is received from the DTCS, after which a time delay is utilized to give an approximate maximum input rate to the GC of six keycodes/sec.

A "bad" CSR response should cause the K-START to display a "non-verify" and subsequently be unsealed, to allow further

operator action to be taken. It should be noted at this point, that as the state of the above mentioned discretes can change at a maximum of only once every second, approximately eight commands could be transmitted Uplink before repeating discrete testing. Figure 631-1 is given as a representative flow, to convey the intent of the subprogram operation.

Operator Action:

During the processing of the input keycodes a test is made to determine whether the range time since "Sealing" the K-START module is greater than or equal to the time delay factor entered via C-START C156. If so, the verify indication is displayed and the subprogram then transfers control to the Uplink Executive program. If not, the module remains "Sealed" to inhibit further input through the K-START module until the time delay has elapsed. This regulates the input rate of keycodes to the GC. A nominal time delay factor is 90 milliseconds.

Console Operator: Operator action is required to initiate this sub-program by entering data via the K-START module keyboard or tape reader.

When a NON-VERIFY display occurs, further character entry is allowed after depression of the NON-VERIFY switch.

For tape mode of operation enter 3100000XXX into C-START. XXX is the time delay factor in milliseconds.

The operator's responsibility includes the monitoring of displays and the initiation of procedures based upon the display interpretation. Normally the status of the "Accept Uplink" discrete was processed by the K-START module subprogram (G&N 631) prior to transmission of data Uplink. However, this discrete is now permanently wired to give a display of "Accept Uplink On", therefore no testing of this bit by this subprogram (G&N 631) takes place. If the "Operator Error On" condition appears, this subprogram will inhibit data transfer through the K-START with a non-verify. The operator will reset this "non-verify" switch and insert a "reset" keycode to clear the "Operator Error" display. Then correct the illegal data sequence and re-enter through the K-START.

An "UPLOCK bit '" display will again inhibit data transfer through the K-START. The operator will reset the "non-verify" and insert a "reset" keycode to clear the discrete. The subprogram will then transmit a "zero" message followed by the "reset" keycode. This may reset the "UPLOCK" discrete and the operator can continue his interrupted sequence of commands by re-inserting the previous keycode.

Two other conditions cause this subprogram to inhibit data input through the K-START, they are a parity error and an invalid keycode. The operator will release the non-verify and apply corrective measures to the input.

If a "Keyerr 2" CRT display occurs, then the operator should re-insert the "Verb 36 Enter" sequence after monitoring the "Gimbal Lock" and "IMU Operate" discrete displays.

Commands inserted via the keyboard will be verified by means of the "closed loop" display, which depicts the GC DSKY status on the CRT, prior to depression of the "Enter" keycodes. The punched tape input, if visual verification is desired, should contain strategically located "stop" codes in the Verb/Noun and parameter sequences, to allow the operator time to perform verification.

Spacecraft Operator: No activity required.

Uplink Requirements: DTCS Transmission: The data word transmitted to the G&N buffer is identified in the Computation Sequence and will be generated as required.

DTCS Stimuli: None

Transmission Time: During G&N testing this will be specified in the Operational Checkout Procedure. All other times will be as required.

Filing: 1) All K-START command information will be recorded on the command tape.

2) Additional recordings for error conditions and discrete inhibits are specified in Table 631-1.

Downlink Requirements: CRT Displays:

1. The time delay factor in XXX milliseconds and the appropriate nomenclature.

2. Program error displays as specified in Table 631-1.

The Program Requirements Process Specification contains the CRT page and line information.

Remarks: Definition of Flow Chart Symbols

Symbol	Definition
KEYWORD	Contains current keycode to be processed.
ZERCODE /	Uplink command to zero the LGC Inlink register for resync purposes.
UPCOM	Contains command word content.
Channel 30 Channel 11 UPLOCK DSPTAB +11	GC Discrete registers, processed by G&N 624 or 224.

Table 631-1

CRT Error Display Definition

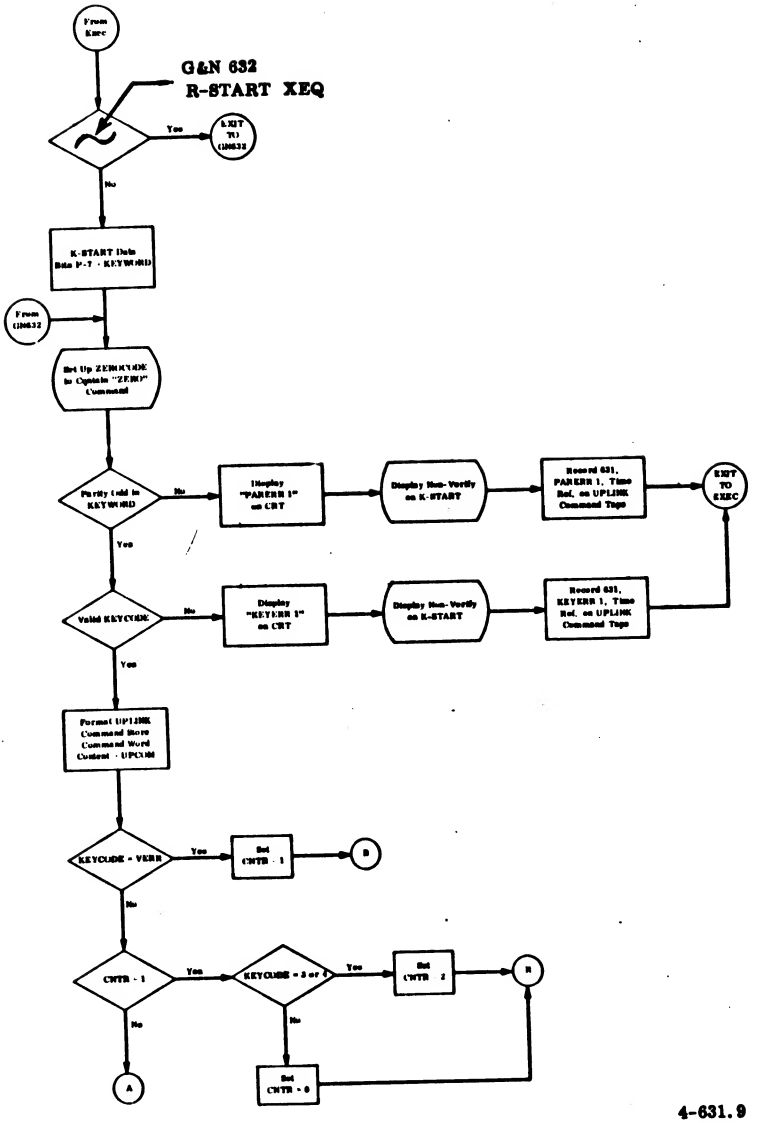
Error or Discrete	CRT Display	K-START Module Display	Command Tape Edit
Odd parity does not exist in the data frame received from K-START module.	PARERR 1	Non-Verify	631, PARERR 1, Time Ref.
An invalid GC keycode has been received by this sub-program.	KEYERR 1	Non-Verify	631, KEYERR 1, Time Ref.
An illegal entry of a V36E has occured.	KEYERR 2	Non-Verify	631, KEYERR 2, Time Ref.
This indicates that an incorrect keycode loading procedure has occured and entry through the K-START is inhibited.	OPERATOR ERROR ON*	Non-Verify	631, Op. Error, Time Ref.

*These CRT discrete displays are set by G&N 624 ACE-S/C Downlink Interpretation Program.

Table 631-2

Legal AGC/LGC Keycodes

Character	Code MSB LSB
0	10000
1	00001
2	00010
3	00011
4	00100
5	00101
6	00110
7	00111
8	01000
9	01001
VERB	10001
RESET	10010
KEY RELEASE	11001
PLUS	11010
MINUS	11011
ENTER	11100
CLEAR	11110
NOUN	11111



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Figure 631-1 (1 of 3)

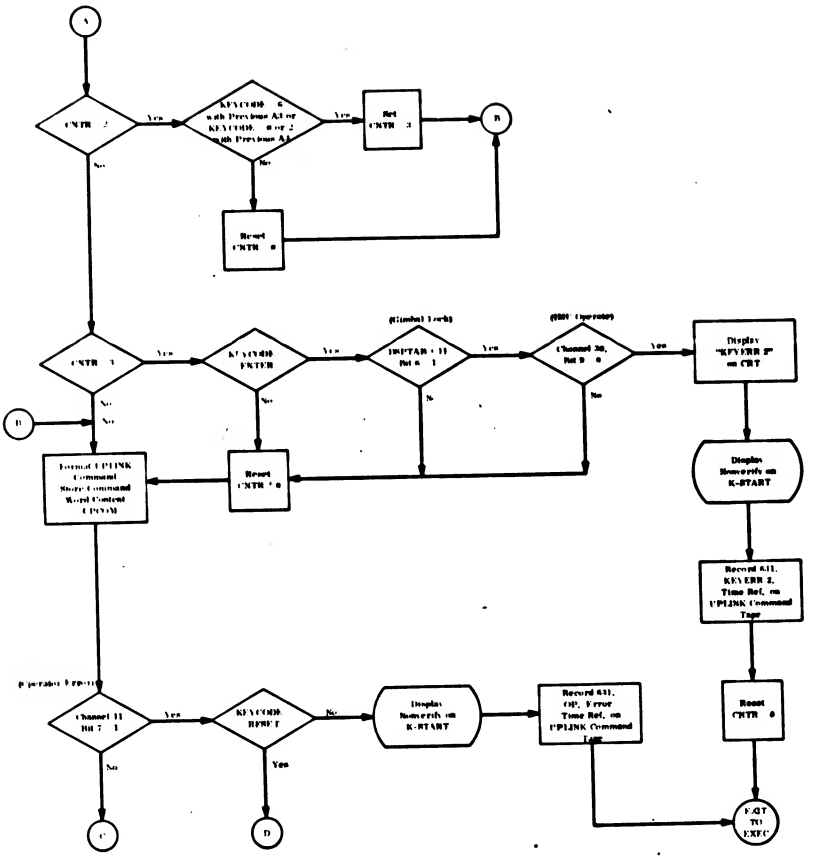


Figure 631-1 (2 of 3)

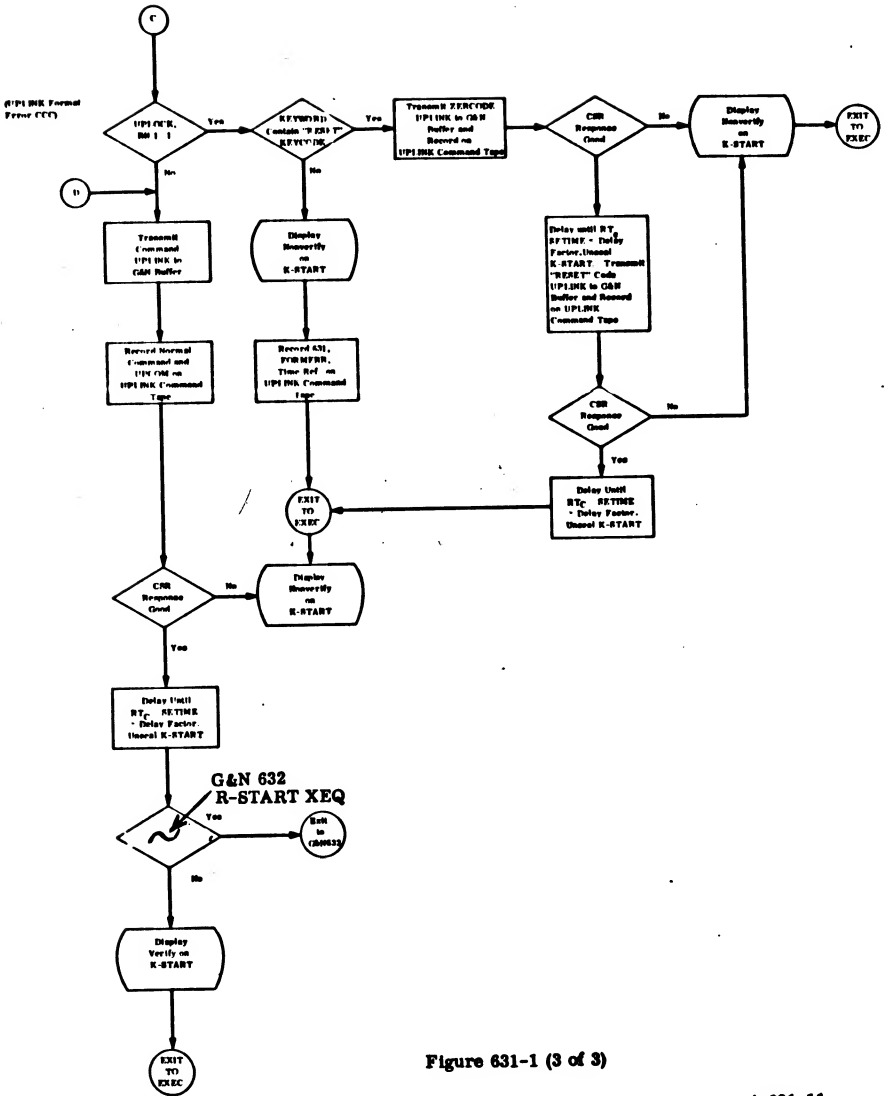


Figure 631-1 (3 of 3)

Title: Special K-Start Load-Verify and Verify Program G&N 632

Part Of: Uplink Program

Purpose: This program is used to check and verify or record the contents of GC erasable memory locations. All data to be verified or recorded is specified on pre-punched K-Start input tapes.

Two options have been provided for verification or recording. Selection of these options is attained through activation of R-Start Module function switches and K-Start.

Calling Sequence: Entry: This program is activated only by the K-Start Module Program (G&N 631), whenever it in turn has been activated and also if the R-Start Module specified in the PRPS or PRD has been executed. Function switches of this R-Start Module specify one of two options used by G&N 632. These are:

1. Load-Verify - Activation of the specified R-Start Module function switch causes G&N 632 to verify that the data being loaded into erasable GC memory locations is identical to the data stored on the K-Start input tape.

2. Verify - Activation of the specified R-Start Module function switch causes G&N 632 to check and verify that the contents of previously loaded and verified GC erasable memory locations have not been altered by internal GC functions or external input means.

Data: This consists of information received from punched K-Start tapes. The data content utilized by this subprogram consists of five bit keycodes plus a parity level.

Normal Exit:

1. Return to G&N 631 whenever keycodes are to be checked for validity and parity and then transmitted to the GC

2. Return to Uplink Executive Program when a complete Special K-Start tape sequence has been processed by G&N 632 and 631.

Error Exit: Error conditions will be displayed on the CRT for operation action.

Computation Sequence:

Activation of this program is attained via the K-Start Module Program, G&N 631 following operator action on the specified R-Start Module and K-Start Module. Execution of the R-Start must occur before K-Start action. The K-Start execute causes the ACE Executive to activate G&N 631 which in turn activates and maintains close interface with G&N 632 provided R-Start Module execution is sensed by G&N 631. If G&N 631 does not detect execution of this R-Start it then treats the K-Start input tape in a normal fashion. The paragraphs below represent a description of the logic contained in the flow diagram shown in Figure 632-1.

Upon entry from G&N 631 various counters and indicators are set to specific values depending on which function switch of the R-Start Module has been executed. G&N 632 then reads the R1 keycode characters into the CDC and seals the K-Start Module. These keycode characters represent the initial VERB-NOUN sequence to be transmitted Uplink.

The format of this "record" is checked for validity. This should be 18 keycode characters for the Load-Verify and Verify tape (the tape format defined in Table 632-1.) Format non-verification results in a CRT error display, K-Start Module release and program control return to ACE Executive. If the Verify option has been selected, the one component load Verb-Noun is changed to one component display Verb-Noun (V21N01 to V01N01).

At this point in the program a loop is set up, based on the value of K1, which loads one keycode at a time into KEY-WORD and allows G&N 631 to perform its normal function of completely verifying each keycode from G&N 632 and transmitting each Uplink. (See G&N 631). After all appropriate keycodes have been transmitted Uplink, the Flash discrete is obtained from the G&N 622 buffer. A test is made on the Flash discrete. If "1" (flashing), G&N 632 delays until the next DSPTAB table is displayed by G&N 622 and repeats the "Flash" test. A third failure in this area should cause an error exit with a CRT error display and a return to ACE Executive.

If the "Flash" discrete is "0" (stop flashing), the program delays until the next DSPTAB table is processed by G&N 622 and obtains the R1, R3, VERB and NOUN values. This delay is to assure G&N 632 that all pertinent GC DSPTAB updated data has been received by the Display Program. Following this delay the Verb-Noun combination for the particular tape option in progress is checked for validity, the input address is compared against the contents of R3 and the input constant is compared against the contents of R1. Any invalid test results in an error exit as specified above.

Following valid testing, G&N 632 releases the K-Start seal, reads one keycode character and checks this code for Key-release. Detection of the Key-release code will result in K-Start module seal and an exit to G&N 631 for Uplink transmission of the Key-release Keycode. When re-entered from G&N 631, the K-Start module is un-sealed, KSEQ "OK" is displayed on the CRT and G&N 632 returns control to the ACE executive. If, however, the first code of the "record" is not Key-release, G&N 632 reads R2-1 keycode characters into the CDC and seals the K-Start Module. These keycode characters represent interim "records" of keycode data necessary for the proper operation of the one parameter Load or Display Verb-Noun combination in the GC. The format of each "record" is tested for validity. An improper format results in an error exit as previously specified. With a legal "record" the program sets up a loop, based on the K2 value, for Uplink Keycode transmission via G&N 631.

Following successful Keycode transmission G&N 632 obtains pertinent data from the G&N #622 buffer and repeats a sequence of testing as specified above.

Operator Action:

Console Operator: To activate G&N 632, the R-Start Module specified in the PRPS or PRD must be executed. Two options are available:

1. One function switch selects the Load-Verify option.
2. The other selects the Verify option.

In addition to the R-Start execute, the K-Start Module must also be activated.

The operator's responsibility also includes the monitoring of displays and the initiation of procedures based upon the display interpretation. Before initiating action to process a Special K-Start tape via G&N 632, the console operator should check and perform the following operations:

1. Depress the NON-VERIFY switch if the non-verify light is on.

2. Check the CRT status of:

Operator Error discrete for "ON"

If any of these conditions exist, Uplink transmission will be inhibited by G & N 631. Recovery Procedures for these conditions are specified in the "K-Start Module Program G & N 631" Computation sequence section.

After verifying that the above conditions have been fulfilled the operator may initiate processing of the Special K-Start tape as prescribed. CRT monitoring should continue during G & N 632 K-START tape processing. Illumination of the NON-VERIFY light will result in the discontinuation of the Special K-Start tape processing. When this occurs, the console operator should record the indicated error in order to initiate corrective procedures. The error displayed will be one of the following:

1. VERROR 1 through VERROR 5 indicates error detection in G &N 632 (See Table 632-2 for definitions.)

2. PARERR 1, KEYERR 1, or Operator Error "ON" indicate error detection in G&N 631.

An error free K-Start tape sequence will result in the CRT display of KSEQ 'OK'.

VERROR Recovery Procedures

One of three operator actions must be taken if G &N 632 detects an error (VERROR type).

1. Re-cycle: This allows a re-run of the present K-Start tape sequence.

 a. Re-load K-Start tape to Verb character.

 b. Re-initiate K-Start action.

2. Continue: This allows tape operation to continue from point of error.

 a. Re-initiate K-Start action.

3. Abort: This terminates processing of the present K-Start tape sequence.

a. Manually insert 'ERROR-RESET' to allow G & N 632 to "unseal" the R-Start module.

Spacecraft Operator:

No activity required.

Uplink Requirements:

DTCS Transmission:

The word transmitted Uplink is identified in the Computation Sequence section of G & N 631.

DTCS Simuli:

None.

Transmission Time:

As required.

Filing:

All K-Start command information will be recorded on the command tape by G & N 631.

Downlink Requirements:

CRT Display:

This information is detailed in the program flow chart and consists of KSEQ 'OK' if no errors occur or program error displays if any are detected by either G & N 632 or G & N 631. If this test is aborted by means of the "ERROR-RESET" code, KSEQ 'NG' will be displayed on the CRT. Error displays are defined in Table 632-2. The ACE Requirements Specification contains the CRT scope page and line information.

Remarks: A definition of terms used in this subprogram is as follows:

1. Flag — Program indicator specifying one of three program options.
2. K1 — Counter which specifies the number of keycodes to be initially transmitted to the GC.
3. K2 — Counter which specifies the number of keycodes to be transmitted to the GC after initial transmission.
4. R1 — Counter which specifies the number of keycode characters to be initially read and processed.
5. R2 — Counter which specifies the number of keycode characters to be read and processed after the initial "record".
6. KEYWORD — Register containing 8 bit keycode for G & N 631 processing.
7. VERROR — Indicator set by G & N 632 whenever errors are encountered. (See Table 632-2.)
8. KSEQ — CRT Indicator set to display 'OK' if a complete Verb-Noun sequence is verified error free. Set to 'NG' if test is aborted due to error detection. Entry to G & N 632 blanks 'NG' or 'OK'.
9. BLKCNT — Value specifies K-Start data block being processed when G & N 632 detects an error. Part of Uplink command tape recording.
10. WDCNT — Value specifies last tape input character which was detected as an error by G & N 632. This word count is used in conjunction with the Block Count value. Part of Uplink command tape recording.

Table 632-1

TAPE FORMATS

Load-Verify and Verify Tape

HEADER
Verb 21 Noun 01 ENTER
4 octal digit address ENTER
5 octal digit constant ENTER
ENTER
4 octal digit address ENTER
5 octal digit constant ENTER
⋮
ENTER
4 octal digit address ENTER
5 octal digit constant ENTER
STOP KEYRELEASE

Table 632-2

CRT ERROR DISPLAY DEFINITION FOR G&N 632

Error	CRT Display	K-Start Module Display
Improperly formatted K-Start tape.	VERROR 1	Non-Verify
Flash discrete 'ON'. Load or display Verb-Noun address and/or data values not accepted by GC.	VERROR 2	Non-Verify
DSPTAB Verb-Noun not same as input Verb-Noun.	VERROR 3	Non-Verify
DSPTAB address (R3) does not verify with input address.	VERROR 4	Non-Verify
DSPTAB constant (R1) does not verify with input constant.	VERROR 5	Non-Verify

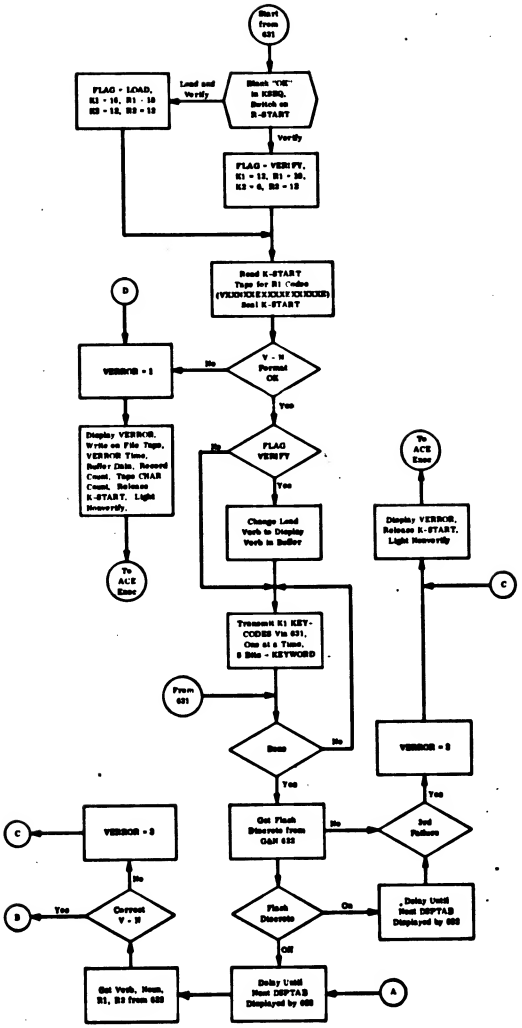


Figure 632-1 (1 of 2)

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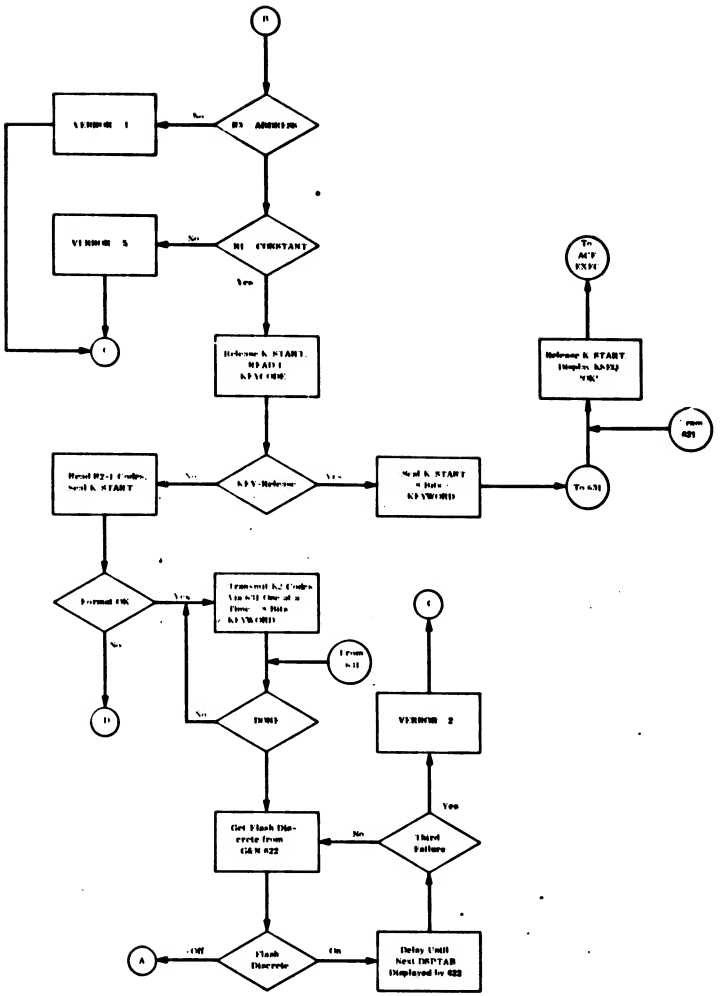


Figure 632-1 (2 of 2)

Title: G&N High Rate Channel Control Program G&N 641

Part Of: Communication Program

Purpose: This program controls the switching of selected signals for transmission over the 400 sample/second high rate sampling channel.

Calling Sequence: Entry: This program will operate under Executive Control and will be initiated from the C-START module specified in the PRPS or PRD.

Data: C-START Module data entry - Window ten (10), eight (8) and seven (7) are set to desired characters.

Normal Exit: Return to Executive Control

Error Exit: None required

Computation Sequence:

This program is entered from the Executive Program when requested by the C-START module. Selector switches eight (8) and seven (7), are utilized for high rate channel selection, while selector switch ten (10) (leftmost selector switch) will be utilized for program identification. Selector switch ten (10) will be tested, and when found to contain the digit two (2), will cause entry into the high rate channel select program. Selector switches eight (8) and seven (7) will be tested to determine which measurement, if any, is being requested. If the code contained in windows eight (8) and seven (7) exceeds the limits of the matrix (i.e. greater than 32 decimal) the program exits to Executive Control. If the code is a valid code, the program tests to determine if the code is the same as the code for the measurement presently displayed. In the event that the selection has not changed, the

signal selection command is ignored and control is returned to the Executive Program. If the code contained in windows eight (8) and seven (7) is a code for a new measurement, the program will then cause the computer to generate the commands necessary to remove the previously selected signal from the matrix and by energizing one or more of the ten high rate control relays in the DTCS, cause the new signal to be switched onto the 400 S/S channel. The relay assignments will be specified in GAEC or NAA Program Requirements Specification. Figure 641-1 is a representative flow diagram of this subprogram.

Operator Action: Console Operator action is required to initiate this program by C-START selection of the high rate signals. The sequence is as follows:

a. The desired program identification digit (2) is entered into selector switch ten (10).

b. The desired measurement identification digits are entered into selector switches eight (8) and seven (7).

c. The XEQ/SEAL Switch is depressed.

Spacecraft Operator: No activity required.

Uplink Requirements:

GC Transmission: None

Time of Transmission: Not defined

Filing Requirements: Measurement ID, time tag

Downlink Requirements:

Measurement ID: The Measurement ID and description is contained in the PSPS or PRD. NOTE: The measurement description is NOT displayed on CRT.

CRT Display: The following CRT display is required "High Rate Meas. GG X X X X", where GG X X X X refers to the NASA measurement number of the particular measurement selected. The measurement number portion of the CRT display for channels with no assigned measurements shall be "XXOOMN" where M and N are the numbers from C-START windows 8 and 7.

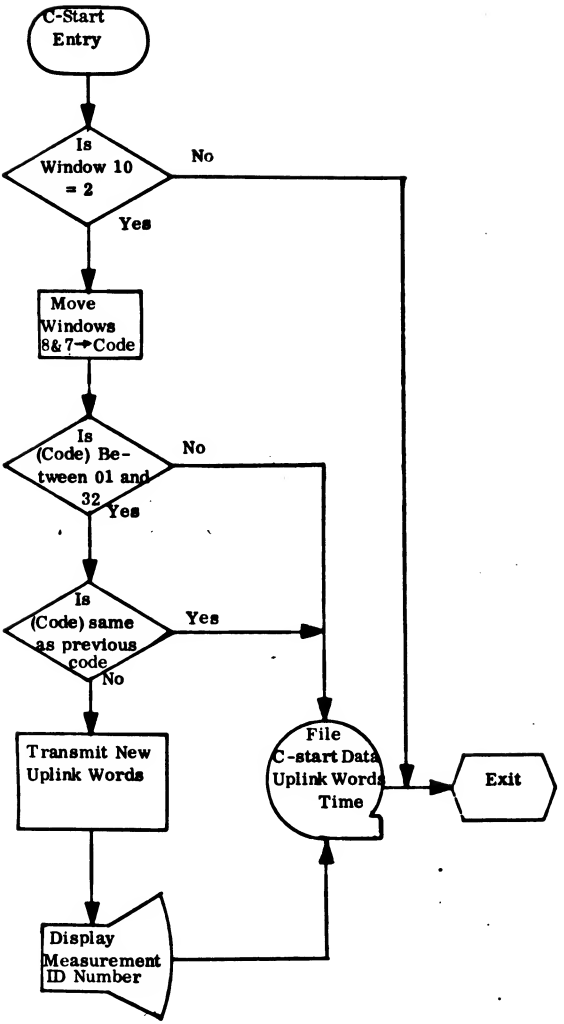
Filing Requirements: None

Remarks:

The high rate measurements are sampled 400 samples per second, spaced symmetrically in the telemetry format, by the analog gates in the PCM carry-on system. The time duration over which the measurement is recorded on the analog recorder is determined by the operator.

The required high rate channel information for any given vehicle will be defined by AC in the Programming Requirements issued in a GAEC or NAA process specification.

Providing an ACE program that will enable switching of all 32 channels will permit further expansion of the list of high rate signals without the need to reprogram the ACE computer. Suitable limit checks on the number of measurements available, perhaps supplied as a card input to the ACE program, would prohibit calling up an unused channel.



Flow Diagram

Figure 641-1

Title: Special IMU Processing G&N 652

Part Of: Communication Program

Purpose: This program converts the IMU 1X gimbal resolver sin and cos PCM values to degrees for display on the CRT. This subprogram specification is identical to the specification for G&N 152 on page 4-152.1.

Title: ACE-S/C Error Reset Program G&N 671

Part Of: Downlink Program

Purpose: This subprogram resets the error displays on the CRT display unit to give a "no error" indication for the ACE-S/C subprograms utilized with the LEM Block II G&N System.

Calling Sequence: Entry: This subprogram operates under executive control and is initiated from the R-START Module specified in the PRPS or PRD.

Exit: Return to Downlink Executive Program after error displays are reset.

Computation Sequence: The error displays reset by this subprogram are listed below, along with the ACE-S/C subprogram that generates them during its operation. The CRT page and line location for each error display is detailed in the Program Requirements Process Specification.

Error Indication	G&N Program Number
TIME ERROR (1)	601
TIME ERROR (2, 4)	602
TIME ERROR (3)	603
SYNCERR (1, 2)	621 or 221
WORDERR (1, 2, 3, 4, 5, 6)	
RELERR (1)	622
PARERR (1)	631
KEYERR (1)	
VERROR (1, 2, 3, 4, 5)	632
FSERR (1)	681

Each error display consists of a variable segment (underlined) which signifies the type of error condition occuring in a particular ACE-S/C subprogram, and a fixed title segment. When initiated by the operator, this subprogram will blank out the variable segments of the error displays.

Operator Action: Console Operator: Operator action is required to initiate this subprogram via the R-START module.

Spacecraft Operator: No activity required.

Uplink Requirements:

The ACE-S/C Uplink system is not utilized.

Downlink Requirements:

PCM data processing is not required by this subprogram.

Title: PIPA Switching and Stabilization Loop Response Test G&N 681

Part Of: Uplink Program

Purpose: This subprogram provides step inputs to the IRIG stabilization loop, for the servo loop response test and enables display of the PIPA signal generator outputs. This subprogram specification is identical to the specification for G&N 181 on page 4-181.1.